Appendix B

EOS GROUND SYSTEM

ARCHITECTURE DESCRIPTION DOCUMENT

December 11, 1991

Submitted To:

GODDARD SPACE FLIGHT CENTER
Code 423
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1.0 INTRODUCTION

The National Aeronautics and Space Administration (NASA) is developing the Earth Observing System (EOS) to observe the earth from space, collect and process the observed data, and distribute them to scientists for use in studies of global change. The observations are made from scientific instruments on polar-orbiting spacecrafts and Earth Probes. The control and monitoring of the instruments; the collection, processing, distribution, and archiving of instrument data; and the analysis of the acquired data are functions of the EOS Data and Information System (EOSDIS). The EOS operational ground system provides the facilities and capabilities required to support these functions.

The EOS ground system includes the EOSDIS and GSFC-managed institutional elements as well as elements from many sources including non-NASA, other U.S. Government agencies, International Partners and user support facilities. The EOSDIS is a part of the total EOS ground system. The EOSDIS consists of the EOSDIS Core System (ECS) as described in Section 2.1 and other components and elements described in Sections 2.2 through 2.9.

Section 1 of this document presents background information about the EOS mission and describes the role of the ground system as an integrated support structure within the EOS program. Section 2 describes the functions of this integrated ground system and presents a architecture of the system. Attachment A provides scenarios to give the reader an understanding of the processes which this ground system supports. Attachment B shows the EOS External Interfaces and organizational responsibilities. Attachment C contains definitions of the acronyms used in this document.

This document contains excerpts extracted from several other documents, namely the Functional and Performance Requirements Specification for the EOS Data and Information System (EOSDIS) Core System, the EOS Executive Phase Project Plan Level I Requirements, the draft Support Instrumentation Requirements Document (SIRD),and the preliminary Interface Definition Document for the EOSDIS Core System.

1.1 EOS PROGRAM OVERVIEW

EOS is a long-term, interdisciplinary and multidisciplinary research mission to study global-scale processes that shape and influence the Earth as a system.

1.1.1 EOS Goals and Objectives

The goal of the EOS mission is to advance the understanding of the entire Earth system by developing a deeper understanding of the components of that system, the interactions among them, and how the Earth is changing. The EOS mission will create an integrated scientific observing system that will enable multidisciplinary study of the Earth, including the atmosphere, oceans, land surface, polar regions, and solid earth.

Mission objectives are:

1) To develop a comprehensive data and information system, including a data acquisition, storage and retrieval, and processing system, to serve the needs of scientists performing an integrated multidisciplinary study of planet Earth.

2) To establish and assemble a global data base for remote sensing measurements acquired from space over a decade or more to enable definitive and conclusive studies of Earth system dynamics and trends.

1.1.2 General Description of EOS

The EOS program, as a part of NASA's Mission to Planet Earth, is a pivotal part of the U.S. Global Change Research Program, contributing to the international effort to understand how the Earth functions as an integrated system. The EOS program consists of space-based measurement system, data and information system (EOSDIS), and a scientific research program. The EOS spacecrafts will provide new capabilities for remotely sensing the Earth, while EOSDIS will make the data and products accessible to the broad scientific community.

1.1.2.1 The Spacecrafts

EOS will use polar-orbiting spacecraft, a new generation of space spacecrafts hosting observing science instruments. Two series of three U. S. spacecrafts are planned with the first spacecraft scheduled for launch in mid 1998. In a cooperative effort, these spacecrafts will be supplemented by two spacecrafts from the European Space Agency (ESA), and one from the National Space Development Agency/Ministry of International Trade and Industry (NASDA/MITI), Japan. In addition, future satellites operated by the National Oceanic and Atmospheric Administration (NOAA) will supply science data. NASA, NOAA, and the U.S. Geological Survey (USGS) have signed data sharing agreements to facilitate scientific research.

The U.S. series of spacecrafts are planned to have two configurations. EOS-A1 and its replacements, EOS-A2 and EOS-A3 will contain surface imagers and tropospheric sounders. The second spacecraft, EOS-B1, planned for launch in June 2000, and its replacements EOS-B2 and EOS-B3 will be devoted mainly to measurements of the upper atmosphere. Each will have a nominal five year mission life. A spacecraft will be launched approximately every 2 1/2 years. There will always be two spacecrafts in orbit after EOS-B1 is launched, except that when one of the spacecrafts in a series is being replaced three spacecrafts will be in orbit. This launch approach will provide a fifteen-year operational life for each of the series. The spacecrafts will be launched from the Western Space Missile Command by a Titan IV. The approximate operational orbit will be near circular sun synchronous with an altitude of 705 km at the equator, and an inclination of 98.21 degrees. Following the completion of useful service, each spacecraft will be safely disposed of via direct and controlled reentry.

1.1.2.2 The Instruments

The selected instruments scheduled for flight on EOS-A1 were identified and announced on January 18, 1991 by NASA. A list of the selected instruments and a brief description of their functions is shown in Table 1.1.2.2-1. However, NASA is presently in the process of rebaselining the EOS program. Consequently, the final decisions pertaining to EOS-A1 spacecraft configuration, payload complement, direct broadcast, and direct readout remain to be made in the near future. It is most likely that the rebaselined payload complement will be a subset of the EOS-A1 instrument set as shown in Table 1.1.2.2-1. Future updates of this document will reflect all rebaselining decisions as and when such decisions are made.

1.1.2.3 The User Community

The user community includes three major categories of users:

1) EOS-funded science investigators

   These include the 551 currently identified investigators and their research support staff funded by EOS for instrument development and scientific investigation. There are three types of EOS science investigators:

   a) Instrument Investigators [a single Principle Investigator (PI) plus Co-investigators (CO-Is)] who perform investigations which include the design, development, test, calibration, operation, algorithm development and data analysis for Earth Observing Instruments.

   b) Research Facility Instrument Teams [a single Team Leader (TL) plus Team Members (TMs)] who perform investigations which make use of one of the Research Facility Instruments and who will contribute to the design, development, test, calibration, operation, data reduction, or algorithm development of these instruments.

   c) Interdisciplinary Investigators (one PI and CO-Is) who analyze and interpret data from EOS research and operational instruments as well as data from other sources.

2) Scientists not funded by EOS

   These include U.S. and international Earth Science researchers at government agencies, universities, and commercial enterprises. They will be able to access the EOSDIS catalog and order EOS data products.

3) Other types of users

   This broad group of users will access EOSDIS information to acquire data for policy planning purposes or to monitor and analyze EOSDIS system usage, capabilities, or performance. In addition, other users include the EOSDIS user support staff that will access the EOSDIS system to assist users in acquiring data sets of interest.

EOSDIS will make EOS data and information available to the user community without a waiting period in which data are considered proprietary. Investigators using data are expected to contribute products back to EOSDIS so that the data and information base maintained by EOSDIS will grow in size and science value over time.

Table 1.1.2.2-1. Selected EOS-A1 Instrument Set

Instrument Name		Science Objective
AIRS	Atmospheric Infrared Sounder	Provide high-resolution infrared measurements to generate temperature and moisture profiles, to give information about atmospheric temperature, water vapor fields, surface temperature emissivity, cloud distribution and spectral properties, and to map trace gases including ozone, carbon monoxide, nitrous oxide, and methane
AMSU-A&B	Advanced Microwave Sounding Unit A&B	Provide measurements of atmospheric temperature and humidity, used in concert with AIRS
ASTER	Advanced Spaceborne Thermal Emission & Reflection Radiometer	Provide high spatial resolution images with multi-spectral channels from visible to thermal infrared addressing those wavelengths specific to minerals of interest; measure cloud properties, vegetation index, digital cloud properties, vegetation index, digital elevation models, soil properties, and surface temperature
CERES	Cloud & Earth Radiant Energy System	Provide continued long term measurement of the Earth's cloud radiative forcing and feedback, observational baseline of clear sky and radiative sky and radiative fluxes, radiant input to atmospheric and oceanic energetics
EOSP	Earth Observing Scanning Polarimeter	Obtain global maps of the radiance and polarization degree for the determination of cloud properties, aerosol distribution atmospheric correction information in support of other science instruments
HIRDLS	Hi-Resolution Dynamic Limb Sounder	Extend the monitoring of important stratospheric chemical constituents (UARS)
LIS	Lightning Imaging Sounder	Provide measurements to determine the global distribution and variability of total lightning, and to help establish a lightning and thunderstorm climatology; to characterize the global electric circuit and the factors that cause it to change
MIMR	Multi-Frequency Imaging Microwave Radiometer	Obtain global observations of a variety of parameters important to the hydrologic cycle: atmospheric water content, rain rate, soil moisture, ice and snow cover, and sea surface temperature
MISR	Multi-Angle Imaging Spectro-Radiometer	Provide measurements of top-of-atmosphere, cloud, and surface hemispherical albedos, aerosols opacity, absorptivity, an loading; provide cloud classification parameters and angular reflectance; vegetation canopy structure and distribution, and tropical ocean phytoplankton pigment concentrations

Table 1.1.2.2-1. Selected EOS-A1 Instrument Set (continued)

Instrument	Name	Science Objective
MODIS-N	Moderate-Resolution Imaging Spectrometer (Nadir viewing)	Provide measurements of land and ocean temperature, ocean color, rates of deforestation, cloud characteristics, aerosol concentrations and properties, temperature and moisture soundings, snow cover and characteristics, and ocean currents
MODIS-T	Moderate-Resolution Imaging Spectrometer (Tilt viewing)	Provide measurements of chlorophyll concentration and primary productivity, sediment transport, cloud properties, aerosol concentrations, hemispherical albedo and bi-directional reflectance, and standing water and wetland extent
MOPITT	Measurements of Pollution in the Troposphere	Obtain global measurements of carbon in the monoxide and methane in the troposphere
STIKSCAT	Stick Scatterometer	Collect all-weather measurements of surface wind speeds and directions over global oceans
ACRIM	Active Cavity Radiometer Irradiance Monitor	Long term measurements of total solar irradiance to determine the influence of variations in solar output on climate change

Note that the MIMR and MOPITT instruments are conditionally confirmed for the first of the EOS-A series pending resolution of technical issues. ACRIM is scheduled as a target of opportunity instrument.

1.1.2.4 EOS Data and Information System (EOSDIS)

The EOSDIS is a data and information system intended to provide the earth sciences community with data obtained by earth observing instruments to be flown on the polar-orbiting spacecrafts. It will produce a variety of standard data products, maintain information about the data and products, provide data archiving and distribution capabilities, and employ a user interface which will facilitate browsing, requests for data, and transfer of data from archives to investigators.

The EOSDIS is responsible for command and control of EOS payloads on U.S. spacecrafts, for monitoring status of U.S. instruments on International Partner spacecrafts, for processing of data, for managing networked multi-media communications, for the short and long term storage of data from EOS instruments as necessary, and for exchanging commands, data, and algorithms with the national Oceanic and Atmospheric Administration (NOAA), ESA, NASDA/MITI and any other non-NASA entity involved in the overall EOS mission. The spacecrafts will provide command interfaces with the instruments, accommodate data flows between instruments and spacecraft subsystems and data storage devices, and format and transmit data to the ground.

EOSDIS will interface with the facilities and functionality of the polar-orbiting spacecrafts; the Space Network (SN) consisting of the Advanced Tracking and Data Relay Satellite System (TDRSS-II), the Tracking and Data Relay Satellite System (TDRSS), the two TDRSS ground terminals, and the Space Network Control (SNC); the EOS Data and

Operations System (EDOS); NASCOM; EOS Communications (ECOM); NASA Science Internet (NSI); the Flight Dynamics Facility (FDF); Ground Network (GN); Deep Space Network (DSN) and other institutional facilities. The ATDRS launch is planned for the late 1990s or early 2000s.

The EOS Data and Operations System (EDOS) will provide data handling, and distribution capability for utilization by EOS.

The EOSDIS will also support an interface with International Partners who will provide spacecrafts, instrument payloads, satellite communications relay, and data acquisition and processing capabilities.

Users of the EOSDIS will interface with the system to retrieve data for their data systems and archives, to support their research programs, and to share and exchange data and information derived from their studies.

1.2 INTEGRATED GROUND SYSTEM CONCEPT

The EOS Program will develop an operational ground system that will provide scientists with improved capabilities to access and analyze data acquired from the instruments on-board the spacecrafts. Functions and services provided by existing earth science data systems will be improved with increased capability, and new capabilities will be provided as required to support the evolving requirements of EOSDIS.

1.2.1 Integrated Ground System Goals and Objectives

The EOS operational ground system consists of an extensive set of geographically distributed facilities, owned and operated by many different organizations. Some of these facilities, such as the EOS Operations Center (EOC), perform unique functions that contribute to the total system, while others, such as the Distributed Active Archive Centers (DAACs), perform similar functions using the same processes but addressing unique science interests. They are contractually developed through several different procurement agencies. Some, e.g. SNC, are provided as institutional support servicing EOS as well as other programs such as the Space Station Freedom Program. Others are developed by the EOS Project under several different EOS contracts, e.g. the EOSDIS Core System (ECS) contract, the EOS spacecraft contract, and the Principal Investigator, Team Leader, Team Member contracts and the EDOS contract(s). Others are non-NASA participants, e.g. the International Partners and NOAA Affiliated Data Center (ADC) contracts.

The ground system must provide complex capabilities. It must support launch, initialization and operation of the spacecraft infrastructure, initialization and operation of the instruments, monitoring and status of the spacecraft and instruments, delivery of data, processing of data, storage and retrieval of data, archiving of data, transfer of measured data to researchers for analysis, transfer of information developed by the users to the central data bases, and transfer of both kinds of data to anyone who has access to the system. This process will be complicated by the need to provide these services concurrently for two and sometimes three spacecrafts, with two of them having uniquely different missions.

Although the process is basically the same for both missions, the users of the data have different objectives and requirements.

The goal of the EOS Operational Ground System is to provide timely acquisition, processing, and distribution of EOS data in its several forms from purely raw data to highly processed information, taking full advantage of the diverse capabilities of the Ground System elements.

1.2.2 Major Contractual Elements

The elements of the ground system must interact to perform as an integrated, useful, and effective system.

Figure 1.2.2-1. shows the major functional components that comprise the total ground system architecture. Each component consists of several elements as listed in Table 1.2.2-1.

Figure 1.2.2-2. is a diagram of the Operational Ground System Architecture, colored to depict the contractual source of funding of each of the elements.

1.2.3 Top Level Schedule

Top level schedules for the overall EOS program and its three constituent projects are maintained in the TBD document.

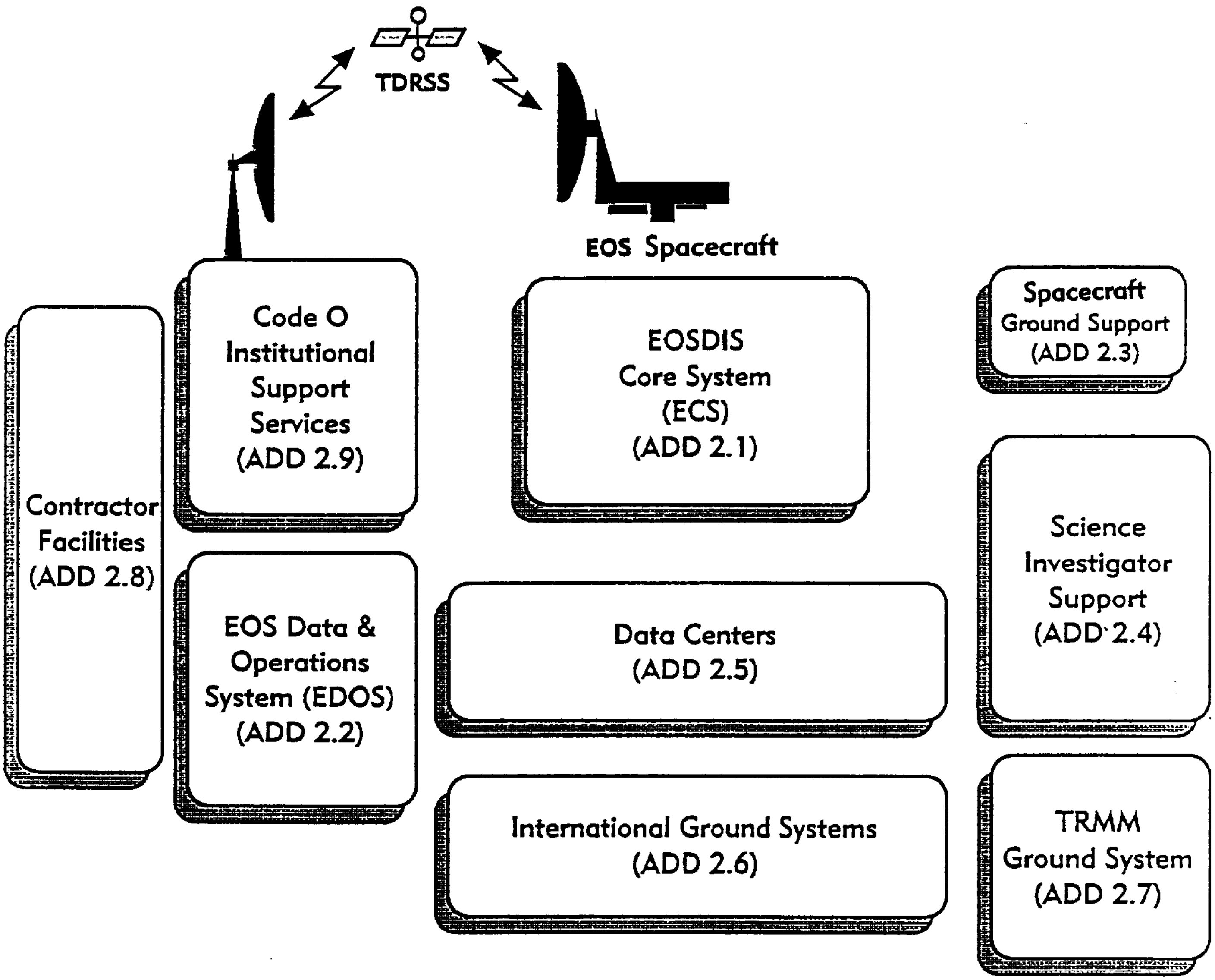


Figure 1.2.2-1: EOS Ground System Components

Table 1.2.2-1. Components and Elements Comprising the Operational Ground System

EOSDIS Core System (ECS) Component
- EOS Operations Center (EOC)
- Information Management System (IMS)
- Distributed Active Archive Centers (DAACs)
  - Product Generation System (PGS)
  - Data Archive and Distribution System (DADS)
  - Distributed IMS
- Systems Management Center (SMC)
- Instrument Control Facility (ICF)
- Instrument Support Terminal (IST)
- EOS Work Station (EWS)
- EOSDIS Science Network (ESN)
- Field Support Terminal (FST)

EOS Data and Operations Component
- EOS Data and Operations System (EDOS)
- ECOM/NASCOM Gateway

Spacecraft Ground Support Component
- Spacecraft Simulation (Spacecraft SIM)
- Spacecraft Analysis Algorithm/Software

Science Investigator Support Component
- Science Computing Facility (SCF)
- User Facilities

Data Centers Component
- Affiliated Data Centers (ADCs)
  - National Oceanic & Atmospheric Administration ADCs
    - National Environmental Satellite Data Services (NESDIS) (one or more data systems affiliated with NESDIS)
    - National Meteorological Center (NMC), Camp Springs, MD
  - University of Wisconsin
  - Consortium for International Earth Science Information Network (CIESIN)
- Non-NASA, Non-EOS Data Centers

International Ground Systems Component
- European EOS Ground System
- Japanese EOS Ground System

Table 1.2.2-1. Components and Elements Comprising the Operational Ground System (continued)

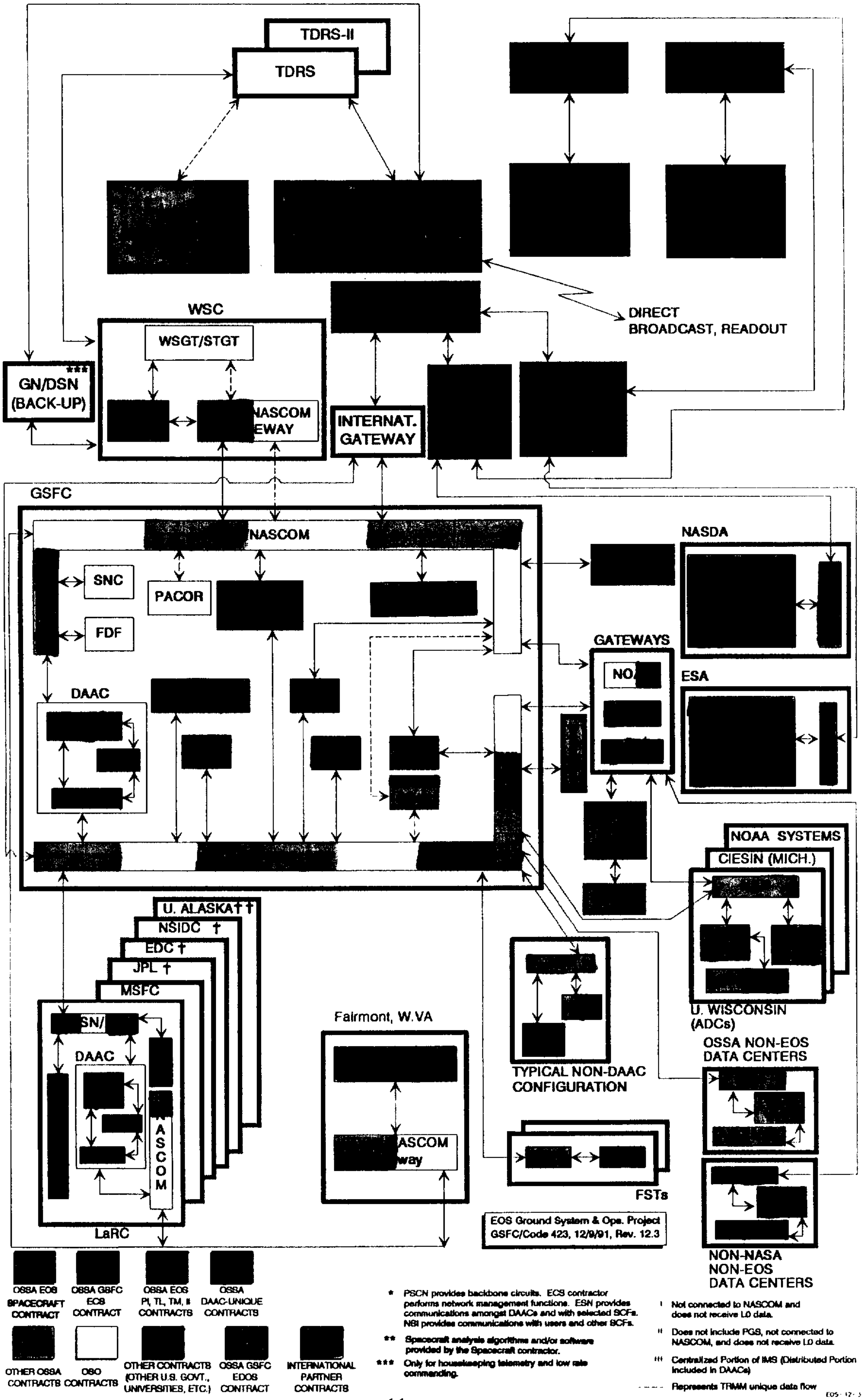
TRMM Ground Support Component
- PACOR Data Collection Facility
- TRMM Science Data & Information System (TSDIS)
  - Science Data Analysis Center (SDAC)
  - Science Operations & Control Center (SOCC)

EOS Contractor Facilities Component
- EOS Spacecraft Contractor Facilities
- ECS Contractor Facilities
- EOS IV&V Contractor Facilities

Code O Institutional Support Services Component
- White Sands Ground Terminal (WSGT)
- Second TDRSS Ground Terminal (STGT)
- ECOM/NASCOM Gateway
- International Gateway
- Ground Network (GN)
- Deep Space Network (DSN)
- Space Network Control (SNC)
- Flight Dynamics Facility (FDF)
- NASCOM[@@]

@@ Partly funded by OSSA and may be referred to as EOS Communications (ECOM)

Figure 1.2.2-2: EOS OPERATIONAL GROUND SYSTEM ARCHITECTURE



* PSCN provides backbone circuits. ECS contractor performs network management functions. ESN provides communications amongst DAACs and with selected SCFs. NSI provides communications with users and other SCFs.

** Spacecraft analysis algorithms and/or software provided by the Spacecraft contractor.

*** Only for housekeeping telemetry and low rate commanding.

† Not connected to NASCOM and does not receive L0 data.

†† Does not include PGS, not connected to NASCOM, and does not receive L0 data.

††† Centralized Portion of IMS (Distributed Portion Included in DAACs)

- - - - Represents TRMM unique data flow

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2.0 GROUND SYSTEM COMPONENT/ELEMENT DESCRIPTION

Section 2 is organized as follows:

Each of the nine components are described according to the following Component Description Template:

2.x.1 Component Relationship to Other Ground System Components

2.x.2 Component Services

2.x.3 Component Interfaces

2.x.4 Component Elements

Geographic Location

Description of Functions/Services

Interfaces, Inputs and Outputs

2.1 EOSDIS CORE SYSTEM (ECS) COMPONENT

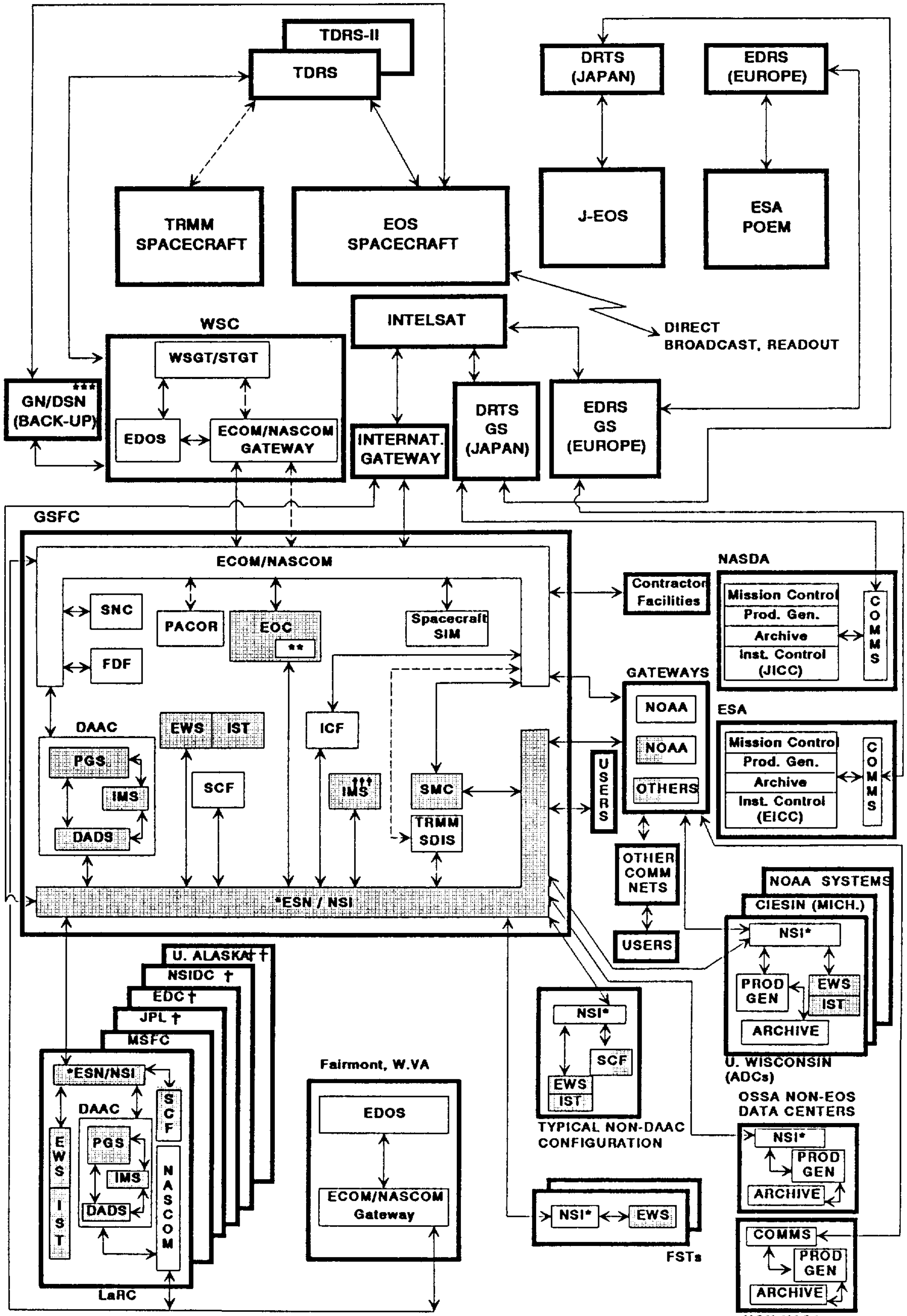
The ECS is the central component of the EOSDIS, providing the coordinating functions for the EOS operational ground system.

2.1.1 ECS Component Relationship to Other Ground System Components

Figure 2.1.1-1. shows the relationship of the ECS component to the rest of the EOS operational ground system. The elements of the ECS component are shaded in the diagram.

2.1.2 ECS Services

The ECS will provide the planning and scheduling, command and control, data processing and management, data archiving and management, system management, communications management, networking, and data distribution functions required to support EOS operations and data access. The ECS will utilize, wherever possible, the functionality and facilities of institutions and organizations external to EOSDIS. This external support includes such facilities and resources as the Polar Orbiting Platforms, the Space Network, EDOS, the FDF, the SNC, and other NASA and NOAA institutional data management and storage facilities. The ECS makes data available to the User community and stores and manages data returned from them.



* PSCN provides backbone circuits. ECS contractor performs network management functions. ESN provides communications amongst DAACs and with selected SCFs. NSI provides communications with users and other SCFs.

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††† Centralized Portion of IMS (Distributed Portion included in DAACs)

---- Represents TRMM unique data flow

EOS Ground System & Ops. Project
GSFC/Code 423, 12/9/91, Rev. 12.3

Figure 2.1.1-1: ECS Component in Context to the EOS Ground System

2.1.3 ECS Interfaces

Figure 2.1.3-1. shows the ECS interfaces to the rest of the ground system, and the high level data flows between them.

2.1.4 ECS Elements

The ECS component is composed of eight functional elements, the EOC, IMS, DAACs, SMC, ICF, IST/EWS, ESN, and FSTs. Of these, the EOC and the SMC are each housed in a single facility. The rest, while functionally performing the same processes consist of multiple facilities in geographically different locations. The location of the facilities is discussed in the description of each element.

2.1.4.1 EOS Operations Center (EOC)

EOC Location

The EOC will be located at the GSFC.

EOC Functions/Services

The EOS Operations Center (EOC) is responsible for mission planning and scheduling and the control and monitoring of mission operations of the U.S. spacecrafts and instruments.

The EOC provides nine services:

- Data Acquisition Request (DAR) Processing
- Planning and Scheduling
- Command Management
- Commanding
- Telemetry Processing including mission monitoring
- Spacecraft Analysis and Management
- Data Management
- Element Management
- User Interface

The EOC serves as the control center for the U.S. spacecrafts, and coordinates mission operations for the U.S. and International Partners (IP) instruments on-board the U.S. spacecrafts. The EOC is managed, developed, and operated as part of ECS. Operationally, the EOC plans and schedules all EOS spacecraft system resources and assembles and generates a conflict free instrument schedule for each Spacecraft. This instrument schedule is based upon observation requests received from the ICF, and pre-planned management information received from the SNC, EDOS, FDF, and Spacecraft Analysis Software. The EOC will merge and validate instrument software loads and command data from the ICF to ensure that preplanned resources or other constraints are not exceeded.

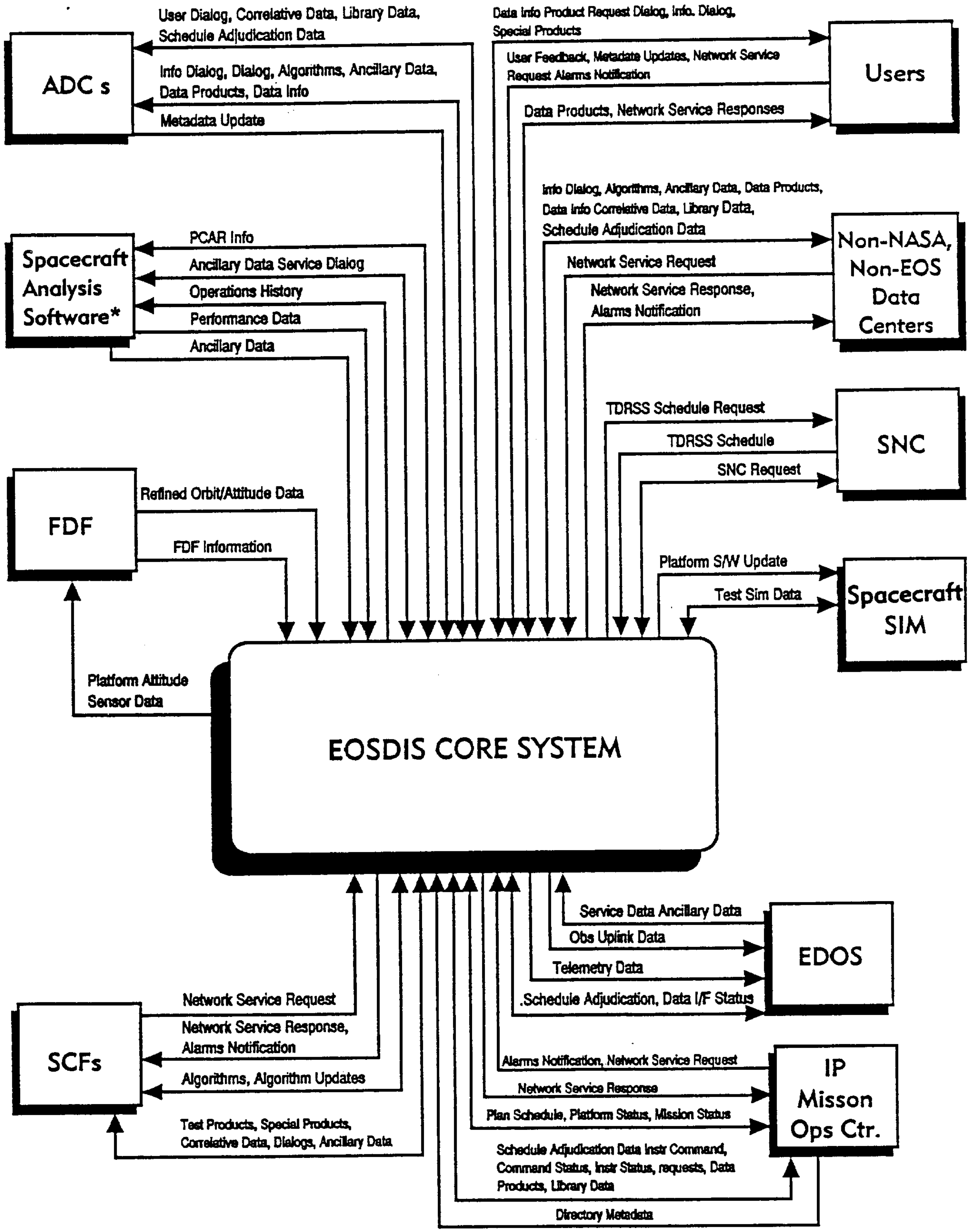

Figure 2.1.3-1: ECS Interfaces and Data Exchanges

* Spacecraft Analysis Algorithms and/or software to be provided by the Spacecraft contractor for hosting in the EOC

The EOC will accomplish real-time and stored commanding, for the EOS Spacecrafts' onboard data systems using the transmission services of EDOS and the Space Network.

The EOC will prepare the detailed operational schedules that support the EOS spacecrafts in orbit at any given time. Planning and scheduling products will include a variety of time lines ranging from seconds to years.

During the replacement of the Spacecrafts (e.g. EOS-A1 by EOS-A2), the EOC will support simultaneous operation of three Spacecrafts for a nominal overlap period of 6 months.

The operations of U. S. instruments on IP spacecrafts is not necessarily coordinated through the EOC, although exchange of information between the EOC and the IP Mission Operations Centers is expected.

The EOC will validate instrument command sequences before transfer to EDOS. To support the validation process, the EOC will assemble and integrate plans and schedules for spacecraft core operations with instrument plans and schedules.

The EOC will provide envelope monitoring of all instruments and will develop contingency plans for use during Spacecraft anomalies. The EOC will interface with the Space Network Control for requesting the use of SN resources, and will support conflict resolution at the instrument level (between Instrument Control Centers).

EOC Interfaces, Inputs, and Outputs

The interfaces to the EOC and the types of data transmitted between the interfacing elements are shown in Figure 2.1.4.1-1.

A definition of the types of data flowing into and out of the EOC are listed in Tables 2.1.4.1-1. and 2.1.4.1-2.

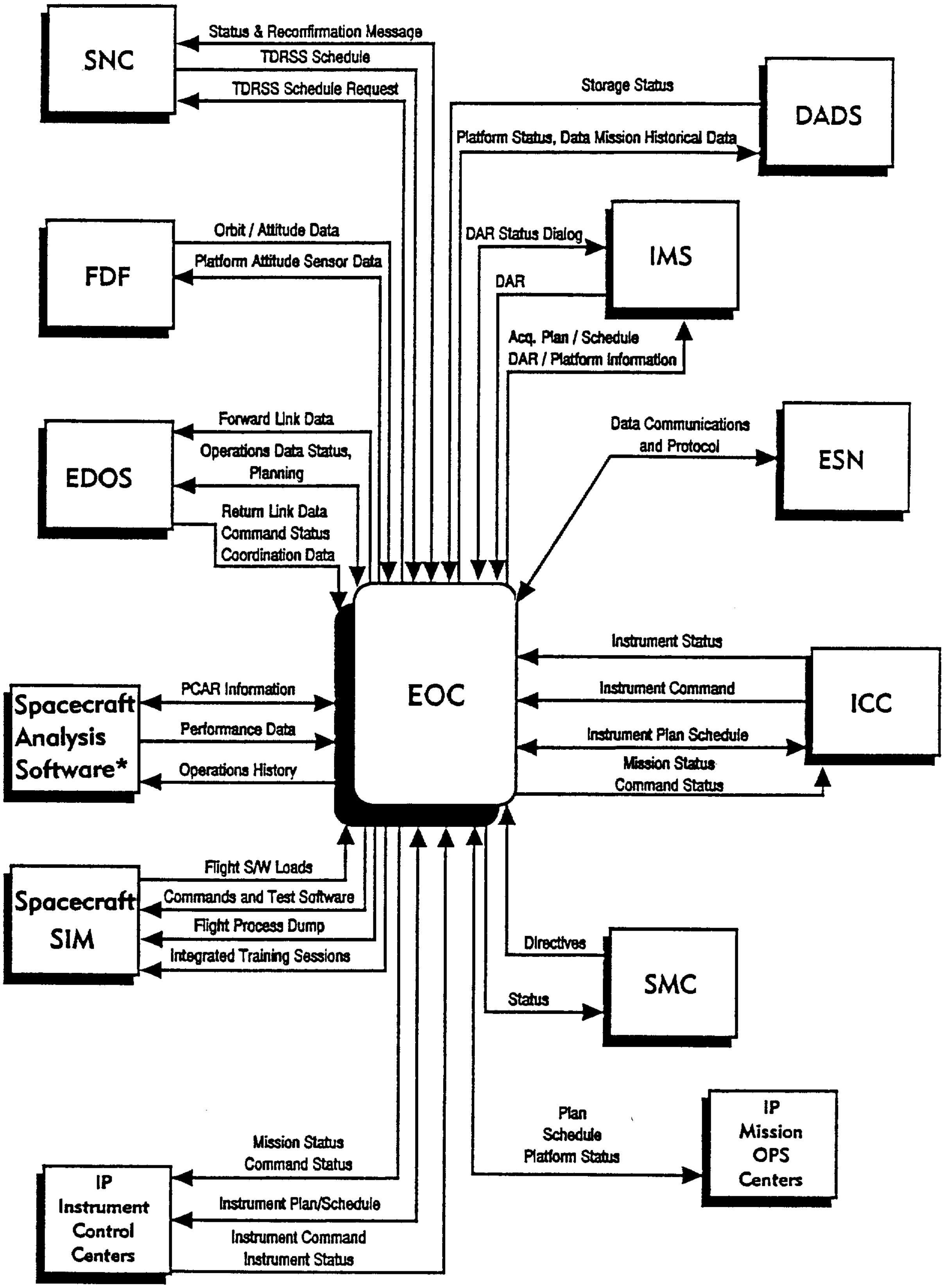

Figure 2.1.4.1-1: EOC Interfaces and Data Exchanges

* Spacecraft Analysis Algorithms and/or software to be provided by the Spacecraft contractor for hosting in the EOC

Table 2.1.4.1-1. Data Flow **into** the EOC

SMC:	EOC management and operations directives
IMS:	User data acquisition requests (DARs) for new data; DAR updates; request for current DAR information
DADS:	Storage success or failure status
IPs:	High level information about the status of one of the spacecrafts, U.S. or foreign, for mission monitoring; allocations and authorizations for spacecraft resources; coordinated observation plans, spacecraft plans, guidelines and priority updates, preliminary DARs authorized instrument schedule; exchange of planning and status data for information coordinated scheduling; high level information about the state of one of the spacecrafts, U.S. or foreign, for mission monitoring; instrument command for uplink to be distributed to the instrument in real-time or delayed on board; high level instrument information, either predicted or obtained from instrument telemetry; instrument resource needs and plans; DAR status; DAR analysis result; schedule
EDOS:	Return link data, coordination data, and spacecraft command transmission status; accounting fault coordination; data operations status and planning
Spacecraft Analysis Software:	Performance analysis information and compatibility assessments; planning and scheduling information; data base parameter information, PCAR information
Spacecraft SIM:	Updates to flight software for uplink to the spacecraft; telemetry data and simulator responses
SNC:	Forecast and active TDRSS and other schedules; status and other reconfirmation messages; requests for TDRSS schedule reconfirmation
FDF:	Predicted orbit data, data used for scheduling contacts including User Antenna View and Predicted Site Acquisition Tables; corrective firing plans for orbit adjustments; precautioned orbit data; contract scheduling data and orbit adjust data
ICCs:	High level instrument information, either predicted or obtained from instrument telemetry, instrument command for uplink to be distributed to the instrument in real-time or delayed on board; instrument resource needs and plans; status of DARs analyzed by the ICC; DAR analysis results, and schedules.
ESN:	ESN network interface responses to users; alarms and exception modifications from ESN elements to SMC for network traffic congestions, threshold and overload conditions, exception events, alarm conditions, security compromise, etc.

Table 2.1.4.1-2. Data Flow out of the EOC

SMC:	EOC management and operations status
IMS:	Status of DARs, copies of acquisition plans and schedules, spacecraft information, including orbit data, used in DAR generation
DADS:	Spacecraft status information and mission operations history for archiving by the DADS
IPs:	Instrument command schedules of U.S. spacecrafts; exchange of P&S data; U.S. spacecraft mission status data; contingency action reports; command uplink status
EDOS:	Forward link command data for distribution to spacecraft or instrument. Accounting, fault coordination data operations status, and planning
ESN:	Users request to access ESN
Spacecraft Analysis Software:	Planning and scheduling information, operation schedules and accept/reject status; history of operations, plans, schedules, commands, processed telemetry, etc.; PCAR information
Spacecraft SIM:	Commands and loads to Spacecraft Simulation
SNC:	Requests for TDRSS contacts; reconfirmation messages
FDF:	Spacecraft sensor data for attitude determination and control
ICCs:	Status information about the mission including command uplink status, spacecraft status, and contingency action reports; allocations and authorizations for spacecraft resources; coordinated observation plans; guideline and priority updates, DARs received for analysis at the ICC, requests for DAR analysis status, authorized instrument schedules; command uplink status, including time of uplink.

2.1.4.2 Information Management System (IMS)

IMS Location

The central IMS will be located at GSFC. The distributed portion of the IMS will be located at each of the seven DAACs, described in Paragraph 2.1.4.3.

IMS Functions/Services

The IMS is a distributed element. The centralized portion of the IMS maintains a master directory of the data bases in the distributed IMS portions, and routes Data Acquisition Requests (DARs) to the appropriate distributed IMS. The central IMS is transparent to the users making requests and receiving data.

Taken as a whole, the primary role of the IMS is to give the users efficient access to the EOS products, providing them with all of the information and tools to search, locate, select and order those products required to perform their science investigations. These products may be stored in the archives or may entail either higher level processing of an archived product or the placement of an acquisition and processing request. The IMS will also assist the users in locating and ordering non-EOS and Affiliated Data Center (ADC) data from cooperating archives.

In addition to providing users with information on data products, the IMS will also provide access to other information required by the users. This will include general mission information, algorithm descriptions, accounting information, and the status of any requests that the scientists have submitted to the system. The sources, and in some cases the maintenance of these information bases will be distributed among the other ECS components including the SMC, EOC, and the DAACs, as well as the EOS scientists themselves.

The IMS services will be distributed among the DAACs so as to provide local information management capabilities at each of the DAACs. The functional capabilities that will be provided by the IMS have been aggregated into the following service categories:

System Access and User Registration
Information Management
Information Search
Archival Product Requests
Data Processing Requests
Data Acquisition Planning and Request Submittal
Data Request Routing and Tracking
Cost Estimation and Account Status Interface
Tool kit Services
Communication Services
Local System Management

The IMS receives directives and user registration information from the SMC, and provides IMS status information and requests for user registration information to the SMC. The directives from SMC include cost estimation algorithms for ECS services, user account balance information, configuration management policy, fault management policy, security management policy, resource management policy, end-to-end product creation threads, and schedule conflict resolution. The status provided to SMC includes configuration management data, schedule conflict alerts, IMS performance data, user assessment of ECS performance, fault data, security data, and resource management data.

The IMS sends product orders for archival data products, algorithms, EOC historical data, spacecraft housekeeping and ancillary data, and documentation to the DADS and receives product and documentation metadata, and product order status from the DADS. As data products are archived and metadata updates are inserted at the various ECS DADS, each DADS sends metadata updates for inclusion in the IMS directory and inventory of data sets.

The IMS will access the PGS product processing schedules for display to users, send user requests for product processing to the PGS, and receive product status from the PGS. Routine standard product processing, defined as product generation which is not user requested and which will occur each time the data inputs are available at the PGS, does not require continual intervention by the IMS. Once the processing thread for these products has been installed at the PGS, the IMS will send one initial processing order to the PGS and the PGS will then routinely schedule the production of these products.

To assist the user in completing a DAR, the IMS will receive spacecraft information and Data Acquisition Schedules and Plans from the EOC, and instrument information from the ICC. Once the user has completed the DAR submittal form, the IMS performs a high level reasonability check on the DAR and forwards the DAR to the EOC for further evaluation and scheduling. As the DAR moves through the EOC scheduling process, the IMS receives DAR status updates from the EOC.

Interfaces, Inputs, and Outputs

The interfaces to the IMS and the data types transmitted between the interfacing elements is shown in Figure 2.1.4.2-1. The types of data flowing into and out of the IMS are listed in Tables 2.1.4.2-1. and 2.1.4.2-2.

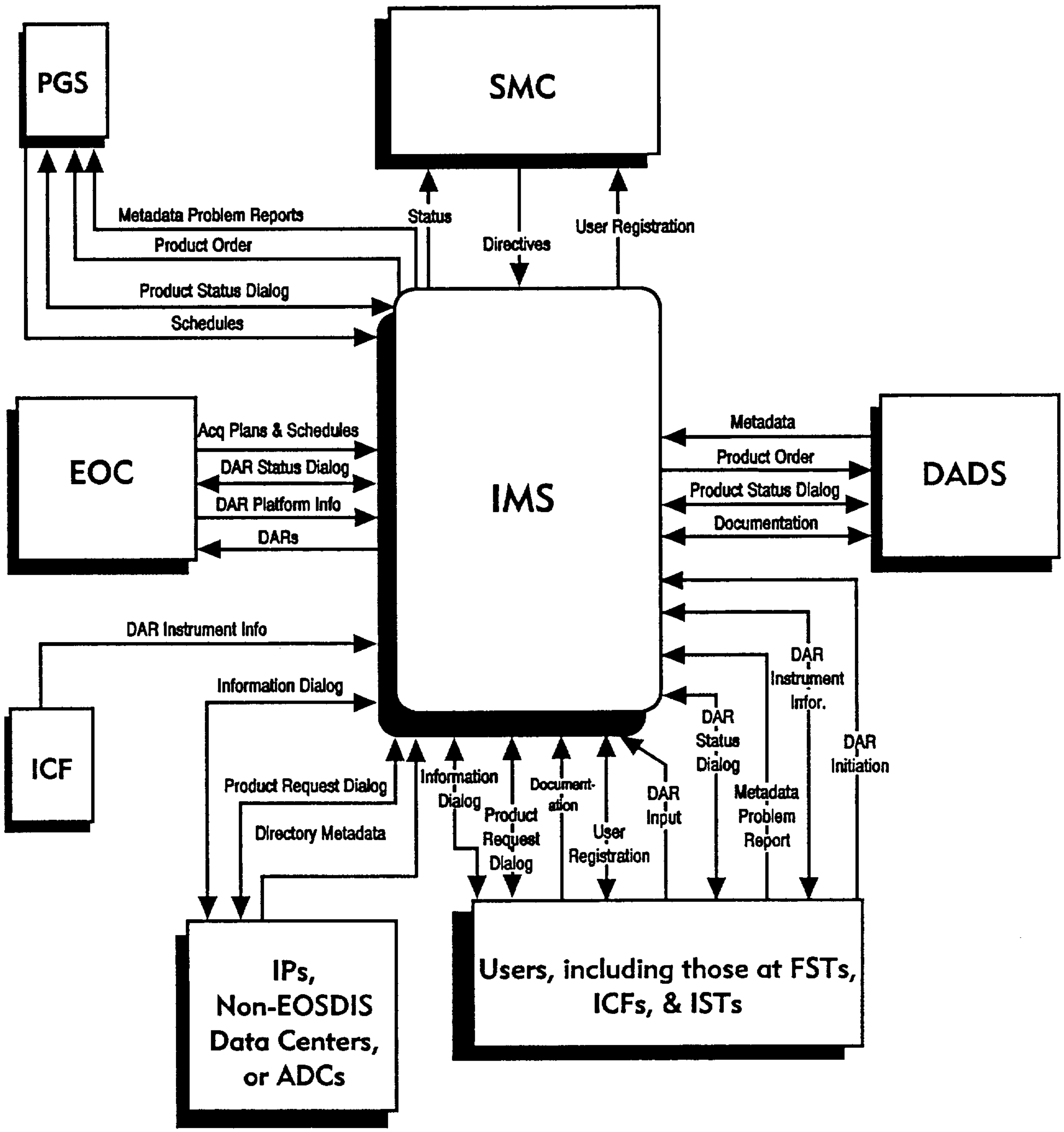

Figure 2.1.4.2-1: IMS Interfaces and Data Exchanges

Table 2.1.4.2-1. Data Flow <u>into</u> the IMS

EOC:	Instrument observation schedules and plans needed for DAR formulation; observation constraints and other information needed for DAR planning
Users:	Parameters and other user information to formulate DARs; DAR initiation; documentation; information, product request, and DAR status dialogs; metadata problem reports; user requests for accounts; information exchange between users and IMS during log-on sessions
ICF:	Instrument constraints and other information needed for DAR planning
SMC:	Policy guidelines, including configuration, fault, security and logistics management information, conflict adjudication, product thread information, user account registration information and user account balance; directives for EOSDIS, processing and resource status from all sites/elements
Non-EOSDIS Centers, ADCs, IPs:	Requests to search the directory, inventory, and data catalog documentation/reference material, search and order the Science Processing Library software, obtain cost centers, estimates for data products, cost status.
DADS:	Information about data,including information about special and standard data products, documentation, spacecraft housekeeping and ancillary data, and standard product software
PGS:	Current status of product processing or distribution; schedules
ESN:	ESN network interfaces responses to users; alarms notification

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Table 2.1.4.2-2. Data Flow <u>out of</u> the IMS

EOC:	DARS and associated processing requests
Users:	DAR status, user registration information; user dialog regarding identification and selection of desired data, browse data and metadata; data product orders
SMC:	Information concerning resource utilization, fault detection, security, maintenance, logistics, and user feedback on ECS; requests for conflict adjudication
IPs, ADCs, non-EOSDIS Centers:	Information dialog relative to data inputs from EOSDIS the Ips, ADCs, and Non-EOS Data Centers; directory metadata
DADS:	Product orders, and requests for data stored at a DADS
PGS:	Information about corrections to metadata; product order; product status dialog
ESN:	Users request to access ESN

2.1.4.3 Distributed Active Archive Centers (DAACs)

DAAC Locations

Seven DAACs will be established to provide adequate data processing, archiving, and distribution of EOS instrument data.

The planned seven DAAC sites will be located at:

GSFC, Greenbelt, Maryland
Earth Resources Observation System (EROS) Data Center, Sioux Falls, South Dakota
Jet Propulsion Lab, Pasadena, California
Langley Research Center, Hampton, Virginia
University of Alaska, Alaska
National Snow and Ice Data Center, Boulder, Colorado
MSFC, Huntsville, Alabama

DAAC Functions/Services

The major purpose of the Distributed Active Archive Centers (DAACs) is to provide facilities for product generation, data archiving and distribution services. Each DAAC will interface with other DAACs for the purpose of routing EOS data products, browse and metadata information, documentation required for interpretation and distribution of desired information and data products to the requested users through the IMS.

DAACs serve as the focal points for these services by producing standard products using algorithms developed by EOS funded investigators. The DAACs facilitate global change research by offering to earth research scientists improved access services to NASA's entire Earth science database. The ECS is the implementation mechanism which will be used to provide a family of seven DAACs. The following paragraphs highlight each DAAC heritage and scientific expertise.

Goddard Space Flight Center (GSFC) in Greenbelt, Maryland

The DAAC at GSFC provides global change research data related to climate, ocean biology, and the upper atmosphere. GSFC has a long term involvement, institutional commitment, and scientific expertise in the use of remotely sensed data in numerical modeling of the Earth's ocean-atmosphere system. Specific GSFC Earth sciences expertise includes science product generation from Nimbus and other Earth science related missions, and archival and distribution of Earth science data through the NASA Climate Data System (NCDS), Pilot Land Data System (PLDS), and National Space Science Data Center (NSSDC).

Earth Resources Observation System Data Center (EDC) in Sioux Falls, South Dakota

The DAAC at the U.S. Geological Survey's EROS Data Center (EDC) Sioux Falls, South Dakota will provide global change research data related to land processes. This capability is directly related to EDC's long experience with processing, archiving, and distributing Landsat data. During the EOS era, EDC responsibilities include Level 1 and higher level processing, archiving and distributing High-Resolution Imaging Spectrometer (HIRIS) and Synthetic Aperture Radar (SAR) data. Additional EDC archive support includes Level 2 data sets from Moderate-Resolution Imaging Spectrometer (MODIS). It also processes, archives, and distributes Level 2 and Level 3 Advanced Spaceborne Thermal and Emission and Reflection Radiometer (ASTER) data.

Jet Propulsion Laboratory (JPL) in Pasadena, California

The focus of the DAAC at JPL will be on processing, archiving, and distributing data of interest to the physical oceanography and air-sea interactions research communities. The JPL DAAC is expected to evolve directly from a number of current JPL activities (e.g., NASA Ocean Data System (NODS) and SAR data catalog). During the EOS era, the primary instruments contributing to JPL studies includes Altimeter (ALT), Scatterometer (SCAT), and Global Positioning Satellite (GPS) Geoscience Instrument (GGI).

Langley Research Center (LaRC) in Hampton, Virginia

The DAAC at LaRC will provide global change research data related to Earth radiation budget, aerosols, and global climate change. Specific current data sets archived at LaRC include: Earth Radiation Budget Experiment (ERBE, Nimbus 6 and 7 ERB) and aerosols (Nimbus 7 SAM, SAGE I and II).

University of Alaska (U of A) in Alaska

The long term objective of the DAAC at the University of Alaska is to serve the ocean and ice research communities (heavily emphasizing polar applications) with Synthetic Aperture Radar (SAR) imagery and with products derived from that imagery. To meet this objective, the major U of A functions include the ability to capture, process, generate and distribute all SAR data directly received at the U of A, and provide a pipeline to data acquired elsewhere.

National Snow and Ice Data Center (NSIDC) in Boulder, Colorado

The NSIDC presently serves the polar oceans and ice research community and is the primary U.S. data archive for snow and ice related data. The major NSIDC DAAC functions include processing, archiving, and distributing sea-ice parameters derived from passive-microwave sensors. The NSIDC DAAC will provide access to data products from low bit rate instruments.

Marshall Space Flight Center (MSFC) in Huntsville, Alabama

The DAAC at MSFC provides global change data related to the hydrological cycle and the dynamics of water and energy in the climate system. MSFC's long term commitment and expertise toward climate hydrodynamics studies includes science and technology development associated with global scale atmospheric circulation. Specific Earth sciences expertise at MSFC includes automating wind measurement methods from GOES satellite imagery and the Laser Atmospheric Wind Sounder (LAWS) facility instrument.

Each DAAC element is made up of three sub-elements. These are:

Product Generation System (PGS),
Data Archive Distribution System (DADS), and,
The distributed portion of the IMS.

The PGS performs data product generation and reprocessing and is responsible for the overall data product generation planning and interface control to the EDOS. The DADS provides staging capabilities to the PGS, as well as long term archive mass storage and data distribution. The IMS accepts requests for data acquisition, processing and distribution. It provides information on the data holdings in the ECS and provides access to other (external) data archives.

The DAACs have overall responsibility for planning and scheduling data acquisition, data storage, networking and the external interfaces for science data processing and reprocessing, archiving and distribution. The DAAC scheduling function will be physically located in the PGS. However, it will be closely coordinated with the PGS and DADS scheduling systems for generating an agreeable schedule for EOS data product generation, archiving and distribution activities. The DAAC data storage function will be physically located in the DADS. It provides a capability not only for data archiving, but also for staging data products, ancillary data, and correlative data used for data product generation by the PGS. The DAAC networking function will be used to connect the functions of PGS and DADS to ensure the proper operations of DAAC and interfaces with external systems.

The DAAC portion of the IMS will access the location of local data as a transparent communication with the central IMS.

DAAC Interfaces, Inputs, and Outputs

The interfaces to the DAACs and the data types transmitted between the interfacing elements is shown in Figure 2.1.4.3-1.

Since the DAACs are comprised of sub-elements, the true data interfaces are between the sub-elements and other elements or between the one sub-element and another. Looked at from a high level point of view, it can be said that the interface is logically from element to element. For the purpose of architecture description, the data exchange is between the sub-elements and other elements and/or sub-elements. Therefore, the sub-element (PGS, DADS, and IMS) interfaces and data inputs and outputs are defined in those sub-element paragraphs.

2.1.4.3.1 Product Generation System (PGS)

Co-located with a local DADS and a local portion of the distributed IMS, each PGS will operate within an integrated environment of an institutional DAAC. Each PGS obtains science, engineering, and ancillary data through the DADS and supports the validation and integration of scientific software and algorithms. The PGS manages and provides production of various levels of science data products as supported scientific algorithms. The data processing support will include Level 1 through Level 4 data processing, generating "*on-demand*" standard and quick look products in support of instrument priority processing. Quick look products include priority processing of performance data to determine operational readiness of on board EOS instruments or field campaign experiments at the Field Support Terminals. Quick look data products may not be Level 0 processed by EDOS.

The PGS provides the IMS with metadata, product status, schedule, and data interpretation documentation. The PGS receives the product order, and product status request from the IMS for identifying and distributing the desired data and data products. It provides the users

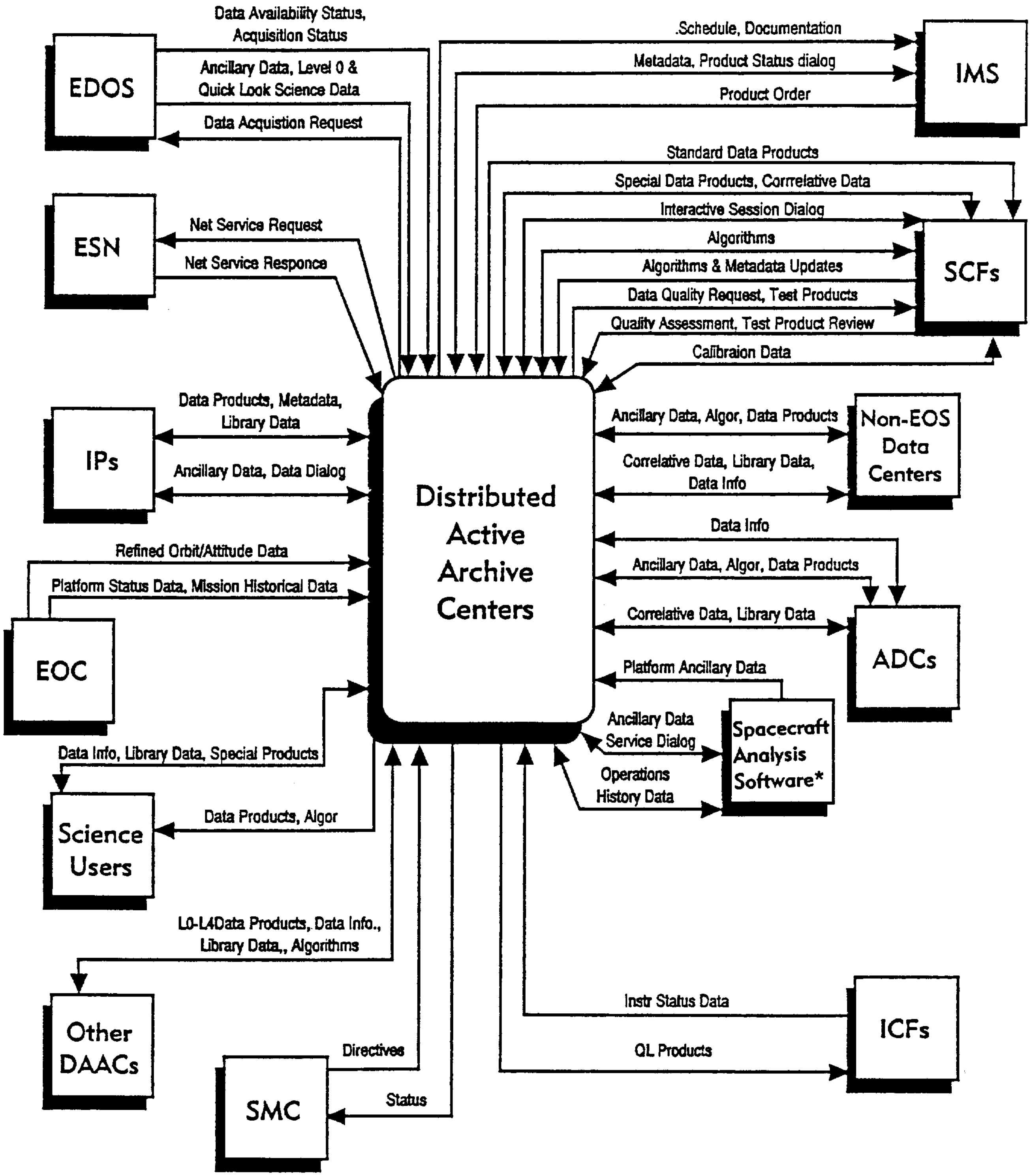

Figure 2.1.4.3-1: DAAC Interfaces and Data Exchanges

* Spacecraft Analysis Algorithms and/or software to be provided by the Spacecraft contractor for hosting in the EOC

with test product, data products, documents, algorithms, correlative data, ancillary data, and metadata. As a result, the PGS receives product quality assessment, algorithm updates, test product reviews, and quality assessment of metadata. The PGS provides four basic services:

Scheduling, Control and Accounting,
Product Generation,
Algorithm Test and Integration,
Product Management.

The Scheduling, Control and Accounting Service receives data availability schedules from remote DADS, EDOS, the IPs, the ADCs and non-EOS data centers, as well as specific processing requests from the IMS. It then organizes and assigns PGS internal resources to processing tasks and generates processing schedules. It coordinates with the DADS to collect and stage data required by the processing schedules and carries out any other necessary schedule coordination with the DADS. It monitors the status of all PGS services and prepares status reports to be sent to the SMC.

The Product Generation Service consumes the largest portion of the PGS internal resources. It receives the necessary input data and algorithm from the DADS and follows the processing schedules to produce Standard Products along with their associated metadata. Some automated product quality assessment will be provided. All data products are delivered to the Product Management Service.

The Product Management Service performs additional quality assessment including man-in-the-loop assessment. Data products are then released to the DADS for storage and/or routing to the appropriate destination.

The Algorithm Test and Integration Service is responsible for receiving new algorithms, algorithm updates and calibration coefficients from scientists at the SCF and ensuring that they operate properly in the product generation environment. Test products are produced and delivered to the SCF for review.

Algorithm validation includes confirming that the algorithm will execute properly in the operational environment but does not include verification of the scientific correctness of the algorithm. Algorithm documentation and source code are evaluated with respect to established standards. This service is also responsible for maintaining configuration management of these algorithms and calibration coefficients via the Local System Management (LSM) provided by the SMC.

The Algorithm Test and Integration Service will provide a set of standard algorithm support routines to be run in the production environment. These routines will be provided as a tool kit, containing the tools needed to simulate the operation of their algorithms in the production environment of the PGS. The routines will provide the access, job control, error logging, dynamic storage allocation, standard mathematical operations such as matrix inversion and fast Fourier transforms, as well as scientific routines composing a science processing library. The source code for these routines will be portable, and will have calling sequences that appear identical to the calling sequences for the corresponding routines in the PGS processing environment.

Interfaces, Inputs, and Outputs

The interfaces to the PGS and the data types transmitted between the interfacing elements is shown in Figure 2.1.4.3.1-1. The types of data flowing into and out of the PGS are listed in Tables 2.1.4.3.1-1. and 2.1.4.3.1-2.

Table 2.1.4.3.1-1 Data Flow <u>into</u> the PGS

Collocated DADS:	Input data files including level 0 through 4 data sets, ancillary data, and non-EOS science data; routes level 0 quick-look or priority processing data; ancillary data; calibration data; metadata
Remote DADS, ADCs and non-EOS sources:	Data availability schedules
IMS:	Processing requests from the processing community; product orders; metadata problem reports; product status
SMC:	Operational directives including priority assignments and resolution of schedule conflicts
SCF:	New or revised algorithms along with associated documentation and test data; Quality Assurance information to meet metadata requirements
EDOS:	Data availability schedules
IPs:	Data availability schedules

Table 2.1.4.3.1-2. Data Flow <u>out of</u> the PGS

Collocated DADS:	Algorithms and schedules; product coordination status, processed data products; metadata
IMS:	Schedule conflicts; copies of PGS processing schedules, product status dialog
SMC:	Regular status reports; copies of PGS schedules
SCF:	Test products generated by the candidate algorithms; request for quality assessment

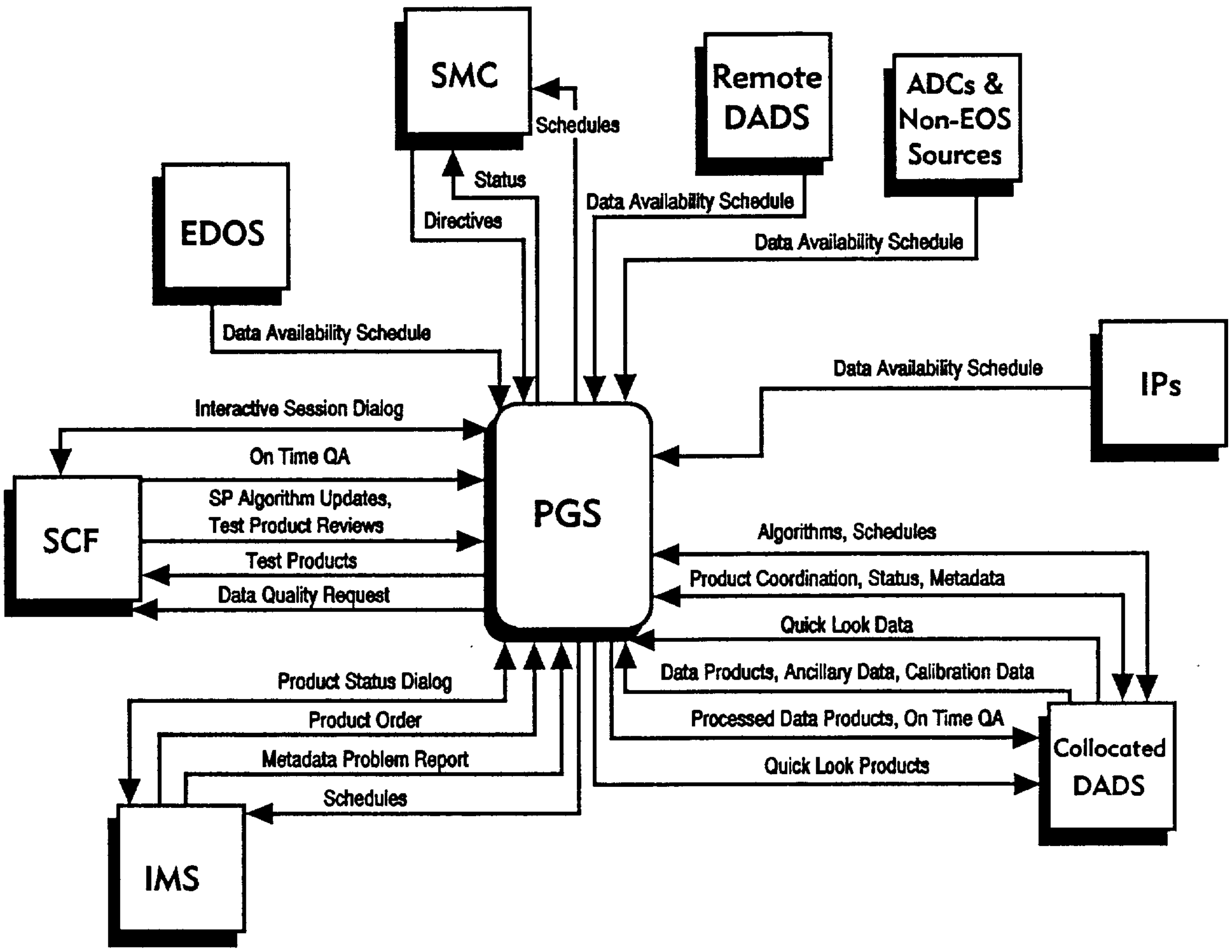

Figure 2.1.4.3.1-1: PGS Interfaces and Data Exchanges

2.1.4.3.2 DADS

Each DAAC contains a DADS collocated with a local PGS and a local portion of the distributed IMS. Each DADS archives the Level 0 data for the DAAC of which it is a part. It collects the data needed for processing at its collocated PGS, archives EOS metadata, and distributes it on request over networks or on a variety of physical media. Science products are provided by DADS to other DAACs, Affiliated Data Centers (ADC) and Instrument Control Centers (ICC) via the ICF, non-EOS Data Centers, International Partners, science teams at their computing facilities, government and commercial users and the general scientific community.

Each DADS receives and stores instrument data from EDOS and International Partners, data products from its collocated PGS, special data products and other information from the SCFs, and ancillary and other data from other archives and institutions. DADS verifies these data, updates their metadata with inventory control and quality assurance information, and stages them for distribution or archiving as necessary. The storage at each DADS is hierarchical, but seamless, and may be composed of devices and technologies of varying capabilities in terms of speed of access, capacity, and cost.

Each DADS routinely accomplishes the retrieval of requested data from the archive, and the processing, or generation of subsets, sub-samples or summary data products. Certain data may be compressed prior to storage or distribution if appropriate.

The DADS distributes data electronically over the EOSDIS Science Network (ESN) or on selected physical media in response to user requests received via the IMS. These are packaged and mailed to the requestor as expeditiously as possible. DADS also provides for the ongoing maintenance and restoration of media as it ages.

DADS management allocates resources and, in conjunction with SMC, monitors and schedules processing, oversees systems, media and communications performance, and provides for the development, testing, and integration of DADS hardware and software.

The interfaces to the DADS and the data types transmitted between the interfacing elements is shown in Figure 2.1.4.3.2-1. The types of data flowing into and out of the DADS are listed in Tables 2.1.4.3.2-1. and 2.1.4.3.2-2.

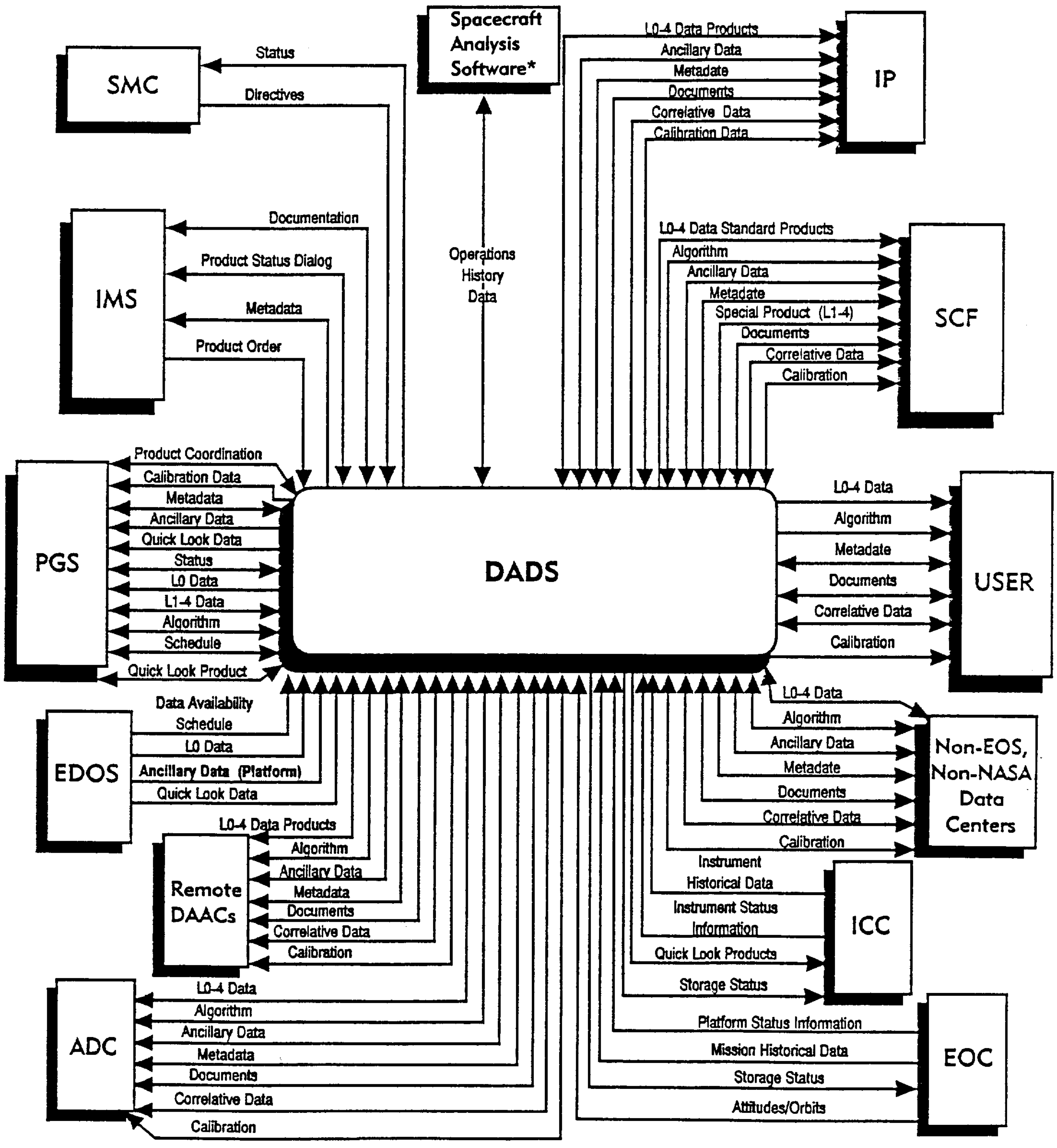

Figure 2.1.4.3.2-1: DADS Interfaces and Data Exchanges

* Spacecraft Analysis Algorithms and/or software to be provided by the Spacecraft contractor for hosting in the EOC

Table 2.1.4.3.2-1	Data Flow <u>into</u> the DADS
Collocated PGS:	Data set metadata; calibration data requests; science data products required to produce other science data products; quick-look data processed prior to being sent to an ICC; level 1 through level 4 data products; operating schedule for the local DAAC
Remote PGS:	Same as for collocated PGS, except the information is relative to other DAACs
IMS:	Authorized orders for data sets located in the archives; requests for product order status
SMC:	Management and operational directives about scheduling, configuration management, and security information
Spacecraft Analysis Software:	Housekeeping and performance status
IPs, Users, ADCs, other DAACs, Non-EOS Data Centers:	Correlative data, ancillary data, metadata, requests for level 0 through level 4 data products, requests for documents, documents
SCF:	Requests for documents, special data products, correlative data, ancillary data, and algorithms
ICF:	Instrument historical data; instrument status data
EOC:	Spacecraft status information; mission historical information; attitude/orbit data
EDOS:	Level 0 instrument and ancillary data; spacecraft housekeeping data; quick look data

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Table 2.1.4.3.2-2.	Data Flow <u>*out of*</u> the DADS
Collocated PGS:	Data files including level 0 through level 4 data sets, ancillary data, and non-EOS science data; routes level 0 quick-look or priority processing data; calibration data; data set metadata
Remote PGS:	Same as for collocated PGS, except the information is relative to other DAACs
IMS:	Notification of problems and/or conflicts; metadata about products; documentation of data set characteristics, status of requests
SMC:	Status of directives
Spacecraft Analysis Software:	Operations history data
SCF:	Standard products for quality assurance or analysis purposes
ICF:	Quick look data processed by PGS, storage status
EOC:	Storage Status
IPs, Users, ADCs, other DAACs, Non-EOS Data Centers:	Documents, metadata, correlative data, calibration data, ancillary data, L0-4 data products

2.1.4.3.3 Distributed IMS

A local portion of the distributed IMS will be co-located with each DADS and PGS. Each local IMS serves as a point of contact for users and provides services associated with the DAAC. The IMS services include twenty four hour access to EOSDIS and EOS information including data from external archives, master directories, catalogs, inventories, documentation and information to support browsing. Each IMS provides help desk services for EOSDIS users in support of a one stop shopping approach for EOSDIS services. EOSDIS user requests for data acquisition and processing are received in the local IMS and forwarded to the DADS. Additionally, the IMS will provide access to the SMC located billing and accounting services.

Distributed IMS Interfaces, Inputs, and Outputs

The IMS interfaces, inputs, and outputs were discussed in Paragraph 2.1.4.2.

2.1.4.4 Systems Management Center (SMC)

SMC Location

The SMC will be located at GSFC.

SMC Functions/Services

The SMC will provide system management services for ECS, communications and other EOSDIS managed ground element and system resources. The SMC ensures effective coordination between all EOSDIS elements and external elements (data systems, archives, science user community). Operationally, the SMC provides centralized configuration management, system and element scheduling, and EOSDIS communication and performance management capabilities, including fault management and security management functions and services. The SMC capabilities will include accounting, billing, and long range planning and management services to ensure adequate resource availability to meet EOSDIS users and earth science community present and future scientific requirements. Additionally, the SMC will provide the tools to support the management and operations of computer hardware and systems software for all sites and elements.

SMC Interfaces, Inputs, and Outputs

The interfaces to the SMC and the data types transmitted between the interfacing elements is shown in Figure 2.1.4.4-1. The types of data flowing into and out of the SMC are listed in Tables 2.1.4.4-1. and 2.1.4.4-2.

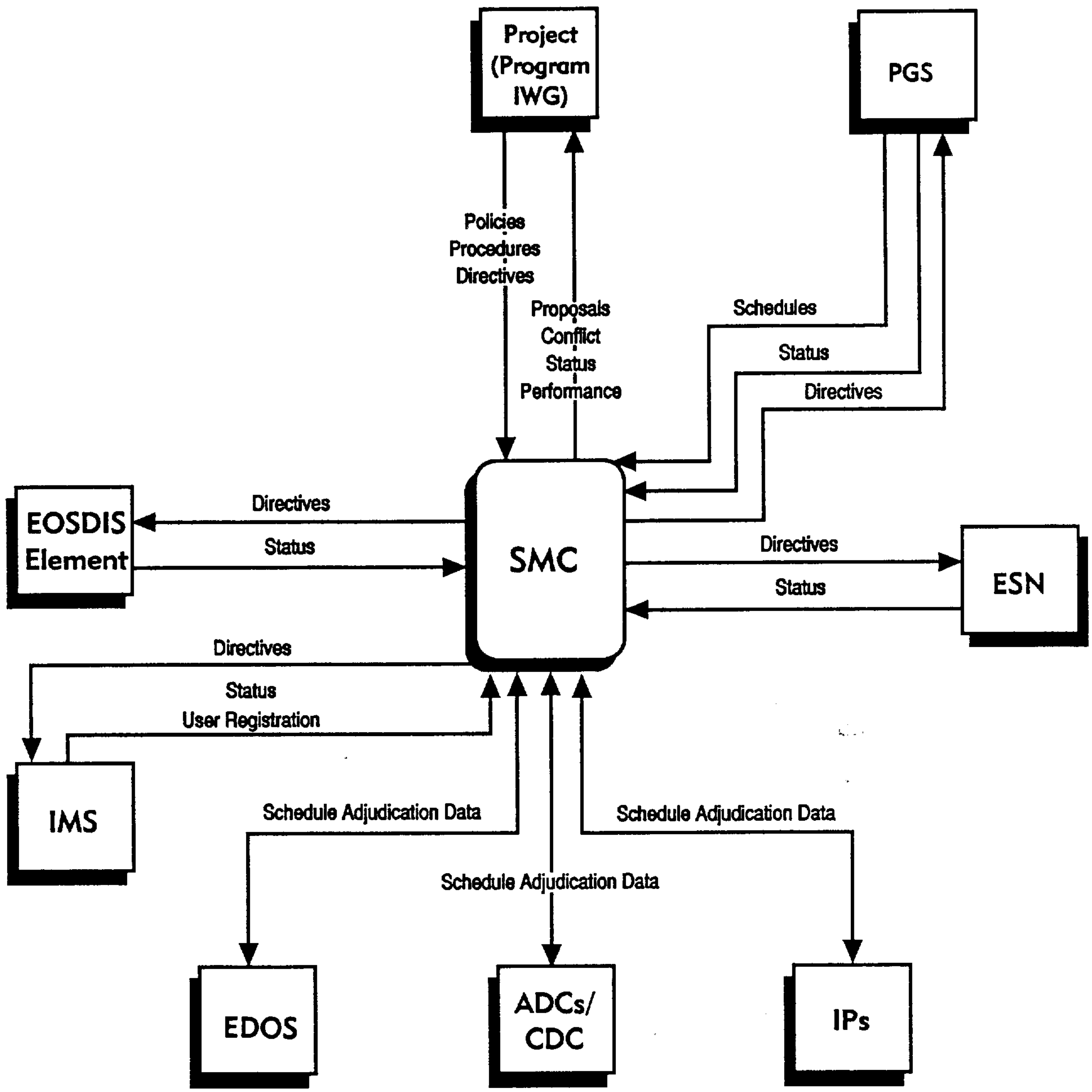

Figure 2.1.4.4-1: SMC Interfaces and Data Exchanges

Table 2.1.4.4-1. Data Flow **into** the SMC

EOSDIS Project Office:	EOSDIS policies, procedures and directives including the overall mission/science data collection, data processing and reprocessing, data retrieval and data delivery guidelines, scheduling conflict and emergency situation directives, user authorization, system upgrade and budgetary directives
ESN:	Directive status
EDOS,ADC ODC, IPs:	Schedule adjudication similar to the schedule conflict data received from the EOSDIS Project Office
IMS:	User registration status
PGS:	Schedules, scheduling plans, processing and resource status

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Table 2.1.4.4-2. Data Flow **out of** the SMC

EOSDIS Project Office:	Enhancement change proposals for approval, system status and performance for review and schedule conflict data for guidance; schedule conflict data such as a description of the conflicting process, their impacts on other processes, all applicable requirements, and elements and/or external systems involved.
ESN:	Directives specific to the ESN
EDOS,ADCs, ODCs, IPs:	Schedule adjudication similar to the schedule data sent to the EOSDIS Project Office
All Elements:	Management and operations directives and operations status, including scheduling, configuration management, performance management, fault management, security management, directory, and accounting/accountability data
PGS:	Priority and other operational directives

2.1.4.5 Instrument Control Facility (ICF)

ICF Location

The ICF will be located at NASA GSFC.

ICF Functions/Services

The ICF will be a collection of several Instrument Control Centers (ICC) which have the prime responsibility for operating the instruments. The ICCs will process real-time instrument engineering and housekeeping data and generate instrument status displays. The ICCs will be used for reviewing quick-look engineering and science data.

The functions of the ICCs will be to plan and schedule instrument operations, generate and validate instrument command sequences, provide capabilities to forward commands in real-time or store them for later transmission in the contingency mode, and monitor the instrument health and safety.

The on-board EOS instruments are commanded by the instrument-specific command loads created by the ICCs within the approved instrument schedules provided by the EOC. The ICC will then forward the command loads to the EOC for transmission.

2.1.4.5.1 GSFC ICF

The Instrument Control Centers within the GSFC ICF are responsible for the planning, scheduling, commanding and monitoring the GSFC-controlled U.S. instruments on board the U.S. and IP spacecrafts. Functionally there is one ICC for each U.S. instrument.

Operating in conjunction with ICCs are ISTs which house software toolkits running on user provided Science Support Interface (SSI) terminals or work stations that are connected to an ICC via the ESN. An IST provides an instrument PI/TL or designee capabilities at their home facilities for viewing and interacting with an ICC. IST capabilities are provided to U.S. investigators with instruments on U.S. spacecrafts or on foreign spacecrafts. In the context of these requirements, the IST is treated as a sub-element of the ICC, but is described separately as components of the ECS in paragraph 2.1.4.6.

The EOC interacts with an ICC to coordinate the planning and scheduling of instrument activities with respect to the overall activities of a spacecraft. The EOC also serves as the collection point from each ICC for the instrument commands required for each spacecraft. An IP is assumed to have a functionally equivalent EOC with which an ICC will interface for a U.S. instrument on an IP spacecraft.

The ICC receives engineering telemetry and selected quick-look science data from EDOS for the purposes of instrument health and safety monitoring. Both real-time and playback telemetry will be received by the ICC. For some instruments, engineering telemetry may be embedded in science data packets, in which case it is extracted from the science data packets by the ICC. Some processed quick-look science data will also be received from a DADS for monitoring.

The ICC will participate in integration and testing of its instrument before launch, provide initial checkout of the instrument soon after launch, and maintain 24 hour operations support for the life-time of the instrument.

The ICF also interacts with the IMS and the SCF for DAR and Status information.

Each ICF provides nine major services:

- DAR processing
- planning and scheduling
- command management
- commanding
- telemetry processing
- instrument analysis
- instrument data management
- element management
- user interface

ICF Interfaces, Inputs, and Outputs

The interfaces to the ICF and the type of data transmitted between the interfacing elements are shown in Figure 2.1.4.5-1.

The types of data flowing into and out of the ICF are listed in Tables 2.1.4.5-1. and 2.1.4.5-2.

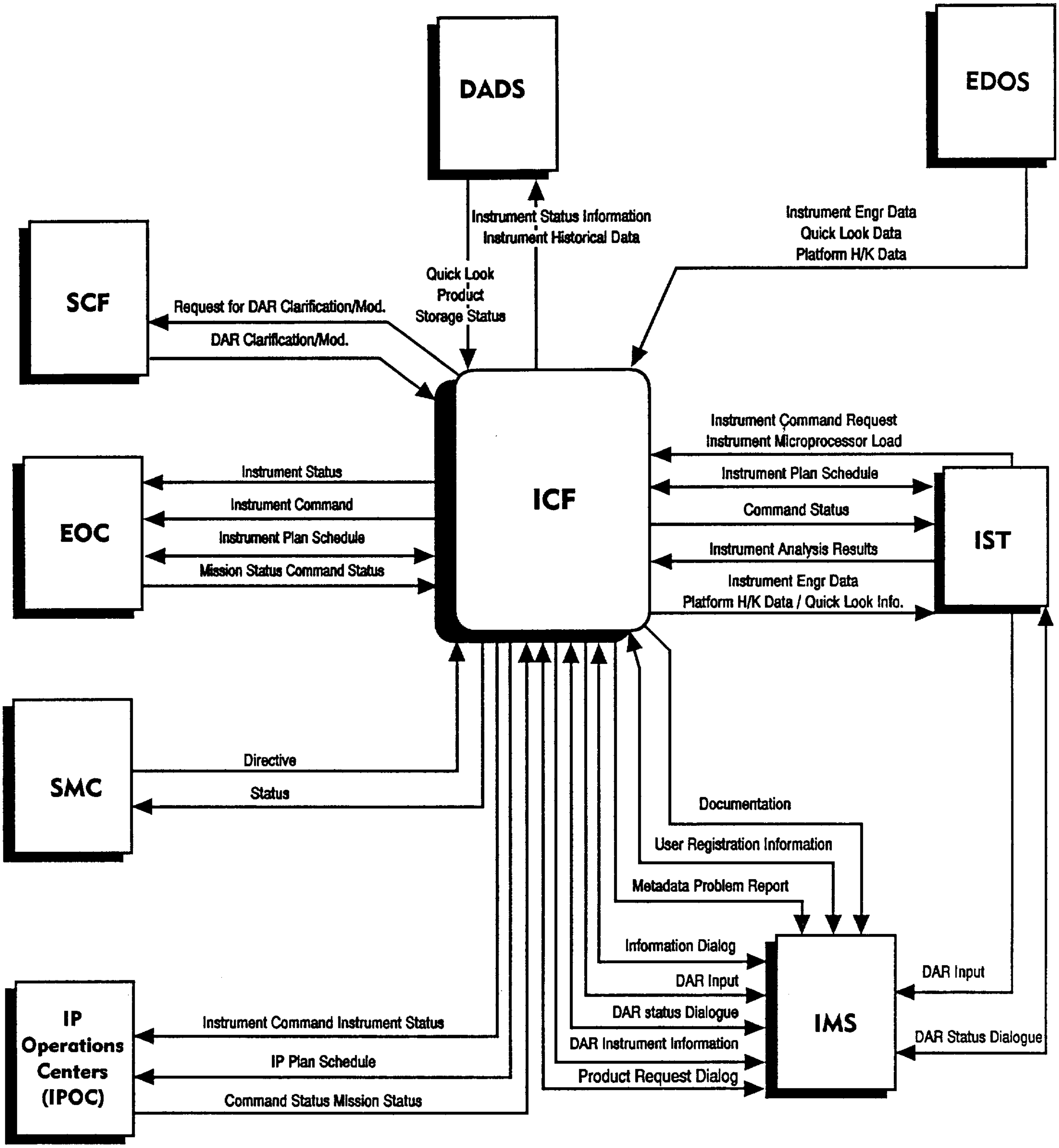


Figure 2.1.4.5-1: ICF Interfaces and Data Exchanges

Table 2.1.4.5-1.	Data Flow <u>into</u> the ICF
EOC:	DARs for initial instrument analysis; proposed short term instrument plan for each instrument; conflict free schedule; uplink status; notification of contingency and emergency command use; instrument status
IST:	Requests for commands to be uplinked; command-sequence-to-bit-sequence translation; micro-processor loads; parameter value ranges and trends; request for instrument monitoring data; data from the instruments operations data base
SMC:	Resource directives
IMS:	DAR status, information dialog, conflict alerts generated by the PGS or DADs and passed to the IMS when products can't be produced within the desired time window, information exchange between users and IMS during log-on sessions
DADS:	Storage status indicating success or failure of data storage; processed quick-look science data
EDOS:	Instrument telemetry data, including instrument housekeeping and engineering, spacecraft housekeeping, ancillary data, and quick look science data
IPOC: (NASDA)	Mission status information; command status information about the uplink for NASDA instruments
IPOC: (ESA)	Mission status information; command status information about the uplink for ESA instruments
Science User:	DAR clarification or modification

Table 2.1.4.5-2.	Data Flow <u>out of</u> the ICF
EOC:	Instrument status; short term operations plan; instrument schedule; instrument commands, microprocessor or table loads; preplanned emergency/contingency commands;
IST:	Planning information for review by the PI/TL; instrument monitoring data; status of command transmission requests
SMC:	ICC management and operations status
IMS:	Instrument information needed for DAR generation; metadata problem report, requests for product processing and distribution of data, user requests for accounts, information exchange between users and IMS during log-on sessions; documentation
DADS:	Instrument command history data; instrument engineering status data;
IPOC: (NASDA)	Command information for uplink to the U.S. instruments on the NASDA spacecraft; high level instrument status
IPOC: (ESA)	Command information for uplink to the U.S. instruments on the NASDA spacecraft; high level instrument status
Science User:	Request for DAR modification or clarification

2.1.4.6 Instrument Support Terminal (IST) and EOS Work Station (EWS)

IST/EWS Location

The ISTs and EWSs are located at the PI/TL/II's home facility.

Functions/Services

An IST is a software toolkit load that runs on a user provided engineering work station that is connected to an ICC via the National Science Internet (NSI) to the ESN.

An IST load provides an instrument PI/TL or designee capabilities at their home facility for viewing data and interacting with an ICC for the respective operation.

Each IST/EWS will provide both ECS managed mission support and NASA HQ OSSA managed work station support (for II) to the Principal Investigator and Earth science researcher. When configured to provide ECS support, the IST interfaces through the NSI and provides the PI operational mission support with the associated ICF. When configured to provide NASA HQ OSSA support, the EWS interfaces through ESN/NSI and provides Earth research support for communication to other NASA and non-NASA data centers.

The IST provides PI and TL access to information about the operations, health and status of the on board instruments. This enables the PI, TL, and engineering support teams the capability for evaluating instrument observation requests, plans, schedules, instrument health and safety, and quick look science data. The PI is capable of communicating with ICF located mission controllers for resolution of instrument performance anomalies investigations, and targets of opportunity.

Monitoring information will be provided by the ICCs to their respective ISTs, allowing the PI/TLs to participate actively in the instrument monitoring activities, when desired or necessary for expert analysis. Analyses of realtime data, playback data, or data from the history log to support the operation of the instrument is coordinated with the IST by the ICC. To support anomaly and long-term analyses, in addition to the calibration of the instrument, the IST will receive and display engineering telemetry from the ICC in both its original state and as processed by the ICC. The IST will also provide the capability to display quick-look products as generated by the ICC and after receipt from the ICC. Instrument status, as determined by the ICC, will be made available to the IST, upon request.

The IST will support the input of DARs into the ECS system. IMS tools resident at an IST will be provided to aid in the construction of the DAR and account checking with SMC prior to the submission of the DAR and subsequent transmission to the IMS via the ESN. The IST will provide access to DARs that are being initially processed by the ICC, so the PI/TL may provide input into their processing.

The IST will provide access to the plans and schedules being developed by the ICC and EOC, so the PI/TL may review the planned instrument use. The ICC provides interactive scheduling capabilities to the PI/TL at the IST to aid in the decision making of the schedule generation. This interactive scheduling at the IST will permit only the generation of "*what-if*" versions of the schedule and not the final schedule. The IST can provide IST instrument microprocessor loads to the ICC when they are generated by the PI/TL. The IST can request the generation and validation of instrument command groups by the Command Management Service of the ICC, as needed.

IST/EWS Interfaces, Inputs, and Outputs

The interfaces to the ISTs and the type of data transmitted between the interfacing elements is shown in Figure 2.1.4.6-1.

The types of data flowing into and out of the ISTs are listed in Tables 2.1.4.6-1. and 2.1.4.6-2.

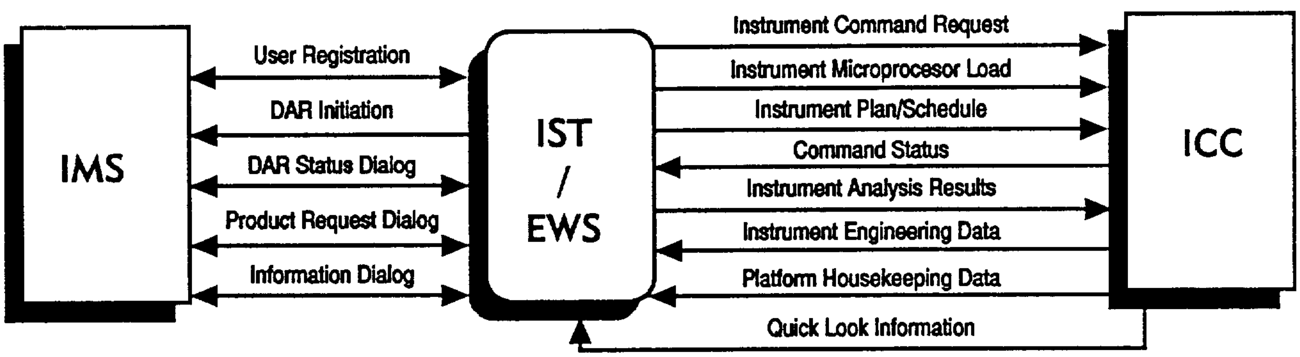


Figure 2.1.4.6-1: IST/EWS Interfaces and Data Exchanges

Table 2.1.4.6-1.	Data Flow <u>into</u> the ISTs
ICC:	Information the TL/PI would require to approve a plan or a schedule for his/her instrument, or suggest modifications to eliminate conflicts, and requests for analysis of a DAR; status of commands requested by the TL/PI; raw and processed telemetry data received from the instrument provided on an as-requested basis to the IST; quick look information, a subset of science data, as defined by the instrument, provided on an as-requested basis to the IST; spacecraft housekeeping data provided on an as-requested basis to the IST
IMS:	Status of DAR submitted at the ICC and response; product request

---

Table 2.1.4.6-2.	Data Flow <u>out of</u> the ISTs
ICC:	Instrument planning and scheduling information, including modification or approval of an instrument plan or schedule, as provided by the TL/PI to the ICC; memory load for the instrument processor including executable code, a table, or the instrument microprocessor's stored command memory, if applicable; request for a command or series of commands from the IST to the ICC in response to anomalous events or as a means to update commands for late occurring scientific phenomena; results of analysis on DARs, instrument housekeeping and engineering data, and/or quick look data or products
IMS:	Submittal of a DAR at the IST; request for status of a DAR submitted at the IST and response; product request response

2.1.4.7 EOSDIS Science Network (ESN)

ESN Location

The ESN is a NASA worldwide complex of science networks, communication circuits, switching, and terminal services including voice, data, facsimile, and video systems. The ESN will be managed by the ESN management center at GSFC and may be collocated with the SMC there.

ESN Functions/Services

The ESN supports the EOSDIS Projects science communications requirements. The ESN will provide communication and data transport services between NASA and non-NASA EOS ground located elements, such as OSSA managed ADCs, SCF, the GSFC ICF, and the IMS distributed at each DAAC. The NASA Program Support Communications Network (PSCN) will provide the backbone circuitry for the ESN and the ECS contractor will perform the ESN network management functions.

The PSCN consists of a mixture of government owned and leased terminal equipment and communication services. The PSCN provides NASA programmatic and administrative communications services for NASA HQ and NASA field centers. Overall responsibility for NASA's PSCN is delegated to MSFC. The PSCN may distribute data between EOSDIS centers or within these nodes. PSCN will distribute non- EOS data between other EOSDIS centers and nodes (JPL, LaRC, NSIDC, EDC, U of Alaska, etc.), the science community, International Participants and others. The NASA Science Internet (NSI) is used by the scientists to interconnect with the ESN.

The ESN will be comprised of a high capacity robust dedicated backbone communications network interconnecting the EOSDIS Active Archive facilities, Local Area Networks (LANs) interconnecting the EOSDIS unique elements located at each archive facility, tail circuits connecting the remote science users and their local facilities to the EOSDIS elements, and gateways to commercial, public, and government agency networks. The tail circuits will consist of a diverse assortment of owned, leased and dial-up links of various capacities and with varying degree of criticality. The design of the EOSDIS will provide for a complex network carrying a diverse data traffic with different local and remote end destinations and quality, privacy, delivery and timeliness requirements.

At the most fundamental level, the EOS network consists of a suite of services layered upon an organized stack of communications protocols. The services fall into the general categories of:

1) Node to node communication service
2) Data transfer and management service
3) Electronic messaging service
4) Interactive service
5) Directory and user access control service
6) Network management service
7) Network security and access control service
8) Internet gateway/router services

The services supported will require compatible protocols implemented on the EOSDIS unique element facilities, LANs, hubs, gateways, tail circuits and science user facilities. The ESN and EOSDIS unique elements will use ISO/OSI protocols in accordance with the GOSIP recommendations to the greatest extent practicable, in order to support compatibility and inter-operability of services at all protocol levels.

ESN Interfaces, Inputs, and Outputs

The interfaces to the ESN and the type of data transmitted between the elements' network interface and the ESN is shown in Figure 2.1.4.7-1.

Based on their attributes and characteristics, the data types that will flow through the ESN are classified as follows:

1) Metadata
2) Browse data
3) Quick look and priority playback data
4) Science product data (level 1 through level 4)
5) Products delivery data (level 1 through level 4)
6) Non-EOS data
7) Inter-investigator data
8) Transactions/documentation data
9) Operations and management data
10) Research results (articles, algorithms, datasets, software)

See the element sections for description of each element's data flow.

The types of data flowing to and from the ESN are listed in Tables 2.1.4.7-1. and 2.1.4.7-2.

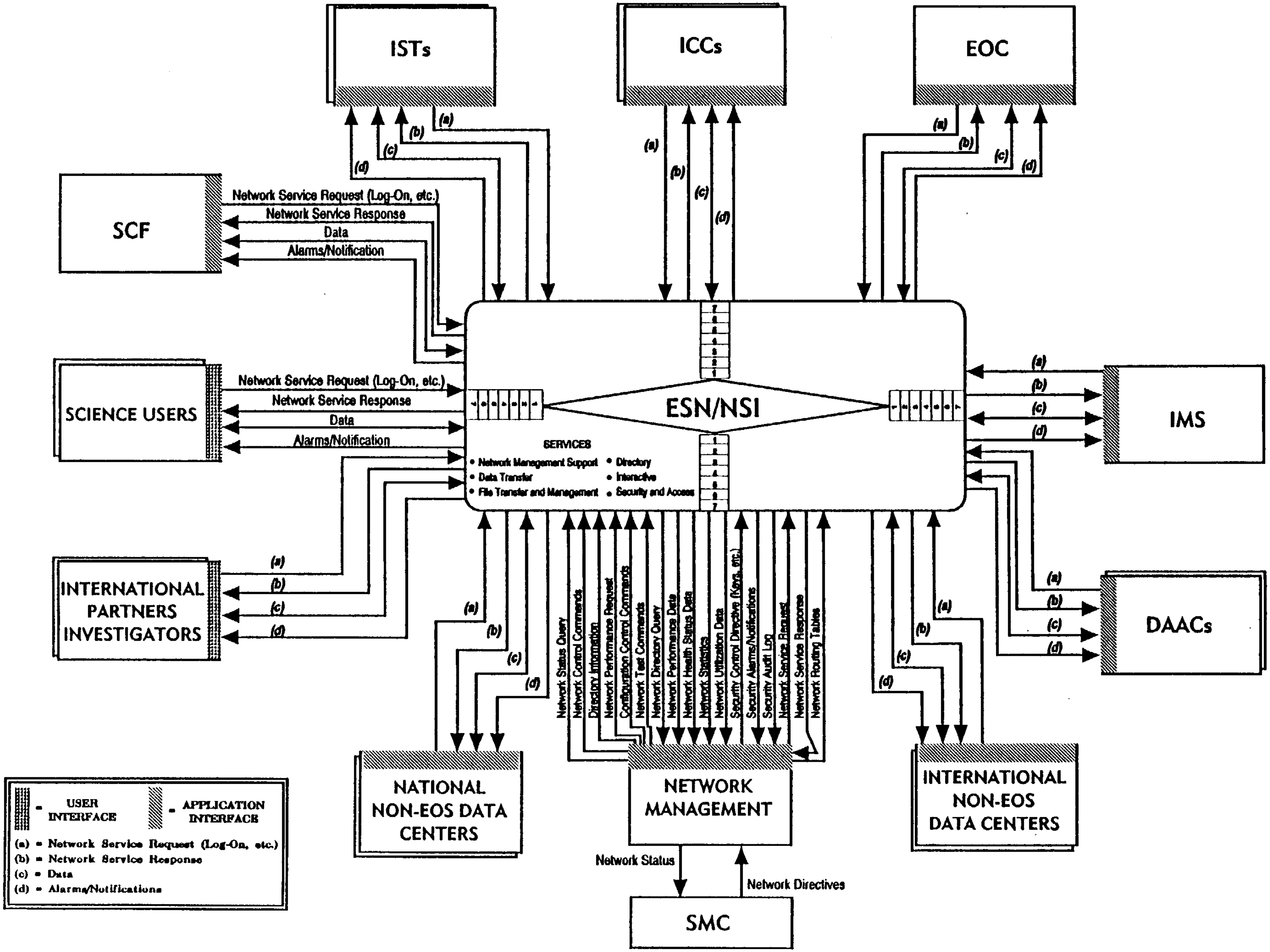


Figure 2.1.4.7-1: Conceptual ESN Element Data Flow Diagram

Table 2.2.4.7-1. Data Flow **into** the ESN for Delivery to other Elements

SMC:	Network directory and security management policies, procedures and directives. Interface is via the ESN management center.
EOSDIS Elements:	User requests to access ESN and its network communication services
Non-EOS Networks:	Network operations related inter-network coordination messages exchanged between the ESN management center and non-EOS network counterpart
ESN Management Center:	ESN management related data such as network performance data request, network health status data, network resource utilization data, network statistics security alarm notifications, and security audit logs.

Table 2.1.4.7-2. Data Flow **out of** the ESN to other Elements

SMC:	Network status - network management related data and reports of overall network health status including information on network resource units availability, outages and their off-normal conditions; network performance and utilization, network statistics and security alarm notifications and audit logs. The interface is via the ESN management center
EOSDIS Elements:	ESN network responses in the form of acknowledgements, confirmations, or rejections; requests from ESN for additional parameters; alarms and exception notification for network traffic congestions, threshold and over load conditions, exception events, alarm conditions, security compromise alert messages, and fault notifications
Non-EOS Networks:	Network operations related internet coordination messages exchanged between the ESN management center and non-EOS network's counterpart
ESN Management Center:	ESN management related queries, requests, commands and directives such as network status queries, configuration control commands, security directives, performance data requests, test commands, network directory information and routing tables

2.1.4.8 Field Support Terminals (FSTs)

FST Location

The FSTs are portable terminals which will be used at field investigation sites. FSTs house software toolkits provided by ECS contractor.

FST Functions/Services

The FSTs are remote EWSs connected to the EOSDIS via the NSI/ESN. The FSTs will be used to support field campaigns and will have access to IMS data, allowing a field investigation team to browse the EOSDIS directories for data of immediate interest, and to request data which could be delivered to the field location for use by the field team. The difference between an FST and IST is that the FST deals only with data, whereas an IST deals with both data and operations information.

FST Interfaces, Inputs, and Outputs

The interfaces to the FSTs and the type of data transmitted between the interfacing elements are shown in Figure 2.1.4.8-1. The data flow to the from the FSTs are listed in Tables 2.1.4.8-1. and 2.1.4.8-2.

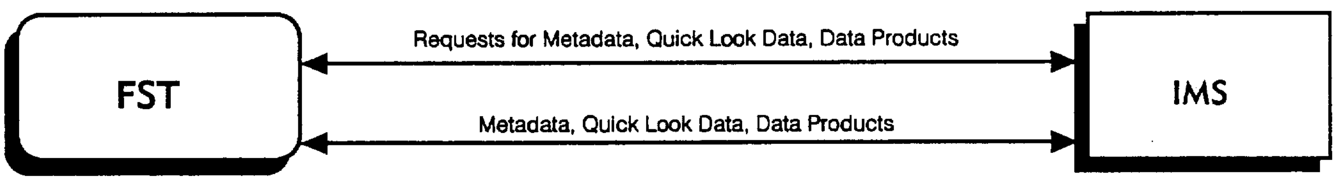


Figure 2.1.4.8-1: FST Interfaces and Data Exchanges

Table 2.1.4.8-1. Data Flow **into** the FST

IMS: Metadata, browse data, quick look data, data products.

Table 2.1.4.8-1. Data Flow **out of** the FST

IMS: Requests for metadata, quick look data, browse data, data products

2.2 EOS DATA AND OPERATIONS SYSTEM COMPONENT

2.2.1 Data and Operations System Component Relationship to Other Components

The relationship of Data and Operations System Component to the other ground system components is shown in Figure 2.2.1-1.

2.2.2 Data and Operations System Component Services

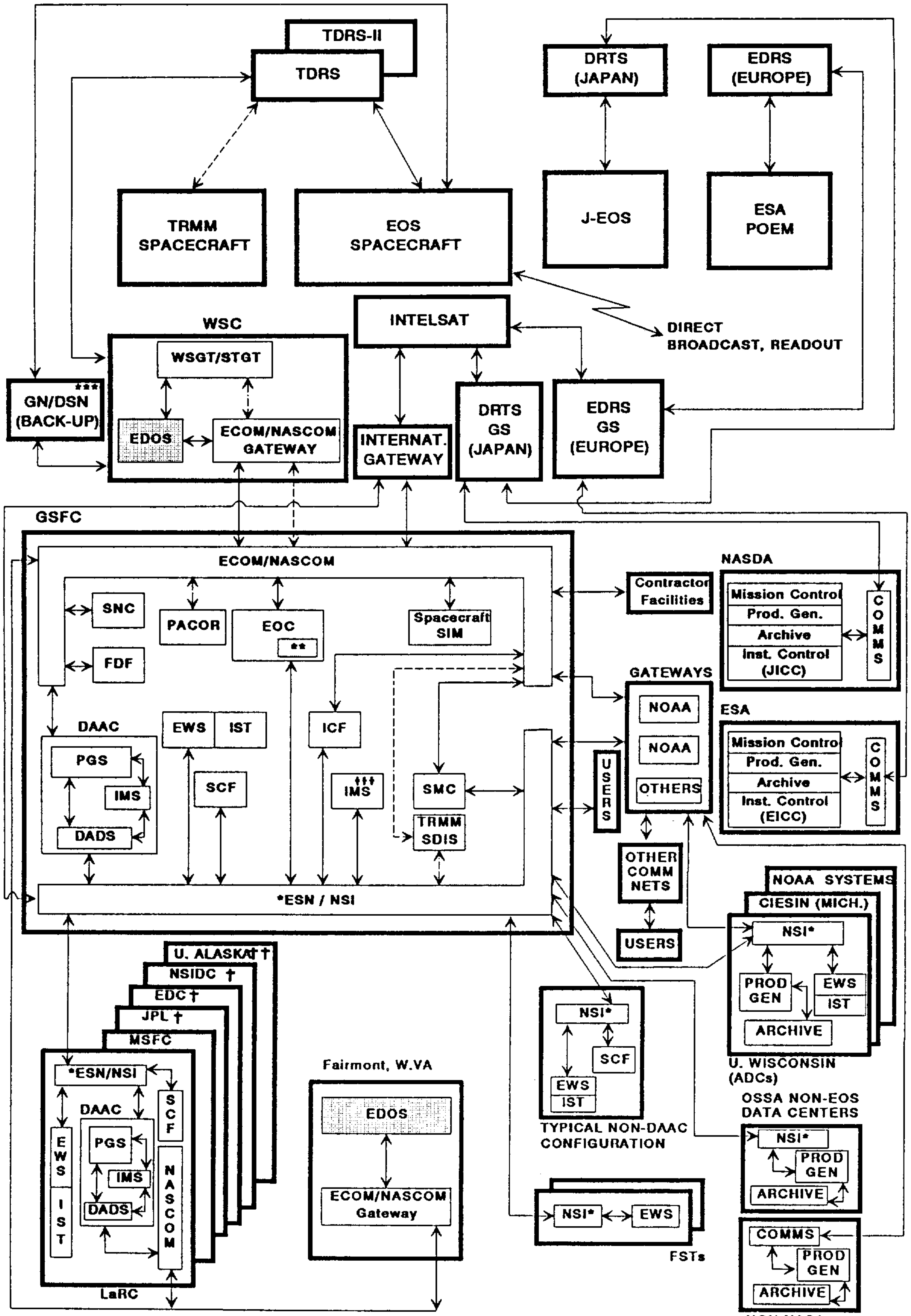
The EOS Data and Operations System Component consists of:

- EOS Data and Operations System (EDOS)
- ECOM/NASCOM Gateway

These elements and a brief summary of the services they provide are listed in Table 2.2.2-1. This component provides data capture, data recording, removal of overlaps, data quality checking and correction, annotation of missing or fill data, and other Level 0 data processing and distribution services pertaining to data received from EOS spacecrafts.

2.2.3 Data and Operations System Component Interfaces and Data Flows

The Data and Operations System Component interfaces and data exchanges are shown in Figure 2.2.3-1. The interfaces and data exchanges shown are external to the component.



* PSCN provides backbone circuits. ECS contractor performs network management functions. ESN provides communications amongst DAACs and with selected SCFs. NSI provides communications with users and other SCFs.

** Spacecraft analysis algorithms and/or software provided by the Spacecraft contractor.

*** Only for housekeeping telemetry and low rate commanding.

† Not connected to NASCOM and does not receive L0 data.

†† Does not include PGS, not connected to NASCOM, and does not receive L0 data.

††† Centralized Portion of IMS (Distributed Portion included in DAACs)

--- Represents TRMM unique data flow

EOS Ground System & Ops. Project
GSFC/Code 423, 12/9/91, Rev. 12.3

Figure 2.2.1-1: EDOS Component in Context to the EOS Ground System

Table 2.2.2-1. EOS Data and Operations System Component Services

Element	Service
EDOS	Data delivery, and operations management services in support of EOS
ECOM/NASCOM Gateway	Protocol conversion and routing and switching functions

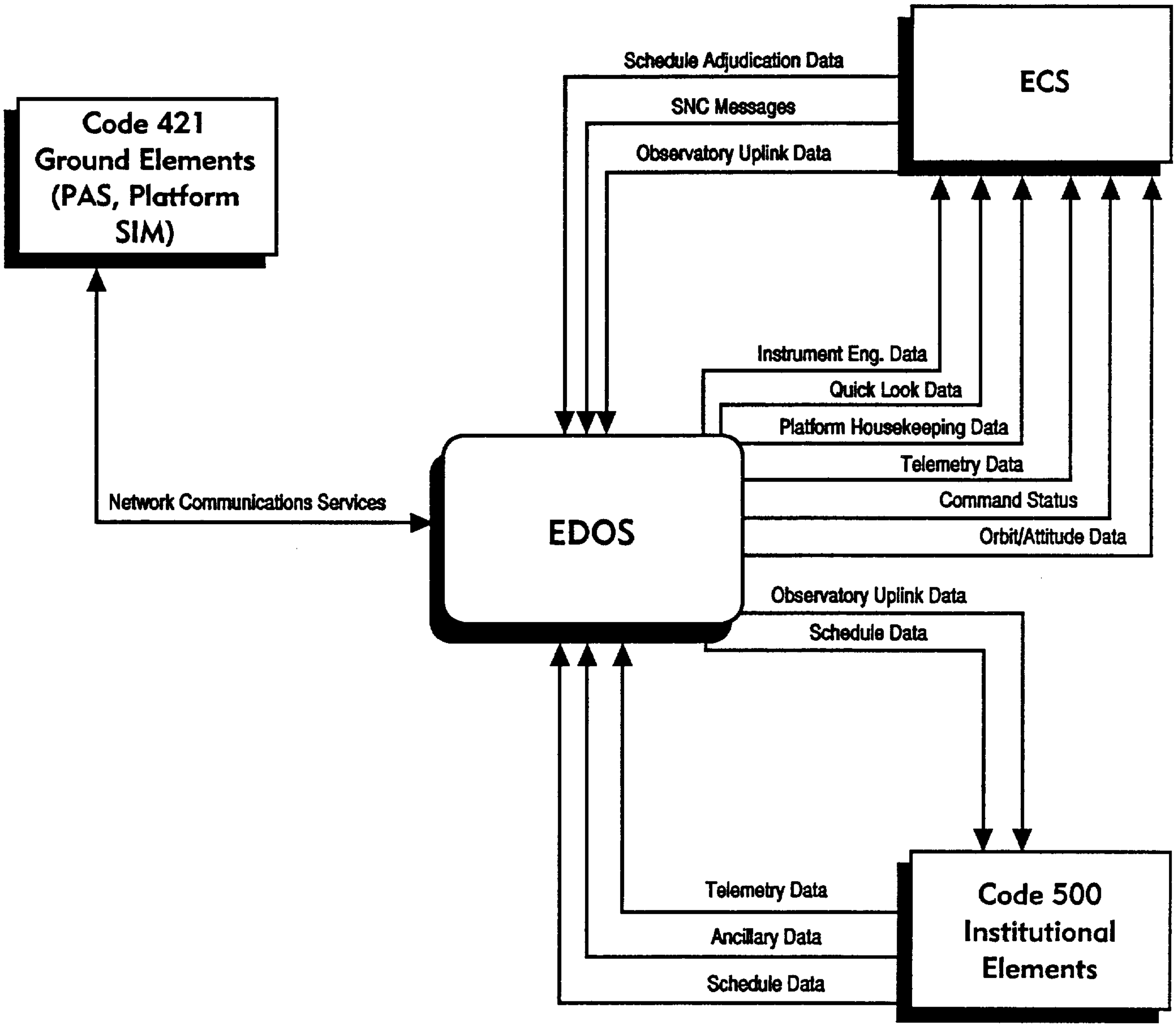


Figure 2.2.3-1: EDOS Interfaces and Data Exchanges

2.2.4 EOS Data and Operations System Component Element Descriptions

2.2.4.1 EDOS

EDOS Location

EDOS will be a distributed system. Major elements of EDOS will be located at White Sands, New Mexico and at Fairmont, West Virginia.

EDOS Functions/Services

EDOS provides space and ground interfaces between the EOS Spacecrafts, the SN/TDRSS, and the EOSDIS ground system. The EDOS will provide data delivery, and operations management services in support of EOSDIS. It will provide EOSDIS a single interface for requesting forward and return link processing, data production, distribution and delivery capabilities.

The EDOS services include the following capabilities: EOS Spacecraft data capture, data recording, tape recorder playback, removal of science data overlaps and duplication, data quality checking and correction, annotation of missing or fill data, disassembly of the multiplexed EOS science data packets interleaved on-board by the Command & Data Handling (C&DH) subsystem, and generation and distribution of production data sets (e.g. Level 0 data) to each EOSDIS-managed DAAC.

Initially EDOS performance capabilities include ingesting data rates of about 925 Mbps from multiple spacecraft. EDOS will generate and distribute production data sets to EOSDIS at a rate of 1 terabyte per day. EDOS will provide to EOSDIS Level 0 processed data sets within 24 hours of data reception. EDOS will provide short-term (24 hour) data storage for all EOS spacecraft and instrument data and storage for engineering and operations data in support of EOSDIS priority playback operations.

EOSDIS supports quick look data processing at each DAAC. These data are routed by EDOS to the appropriate DADS for Level 1 processing by the PGS, at a higher priority if requested. Typical turn-around time by EDOS or EOSDIS is expected to be three to four hours, and assumes that Quick Look data sets are a small percentage of the data acquisition and processing requirements (e.g. 5%).

EDOS will receive EOS instrument engineering and science data from the Spacecrafts in real-time or through playback of the on-board tape recorders. The two routing paths are priority dependent and determined by standard or quick look data processing requirements.

EDOS Interfaces, Inputs, and Outputs

The interfaces to EDOS and the type of data transmitted between the interfacing elements are shown in Figure 2.2.4.1-1.

The types of data flowing into and out of EDOS are listed in Tables 2.2.4.1-1. and 2.2.4.1-2.

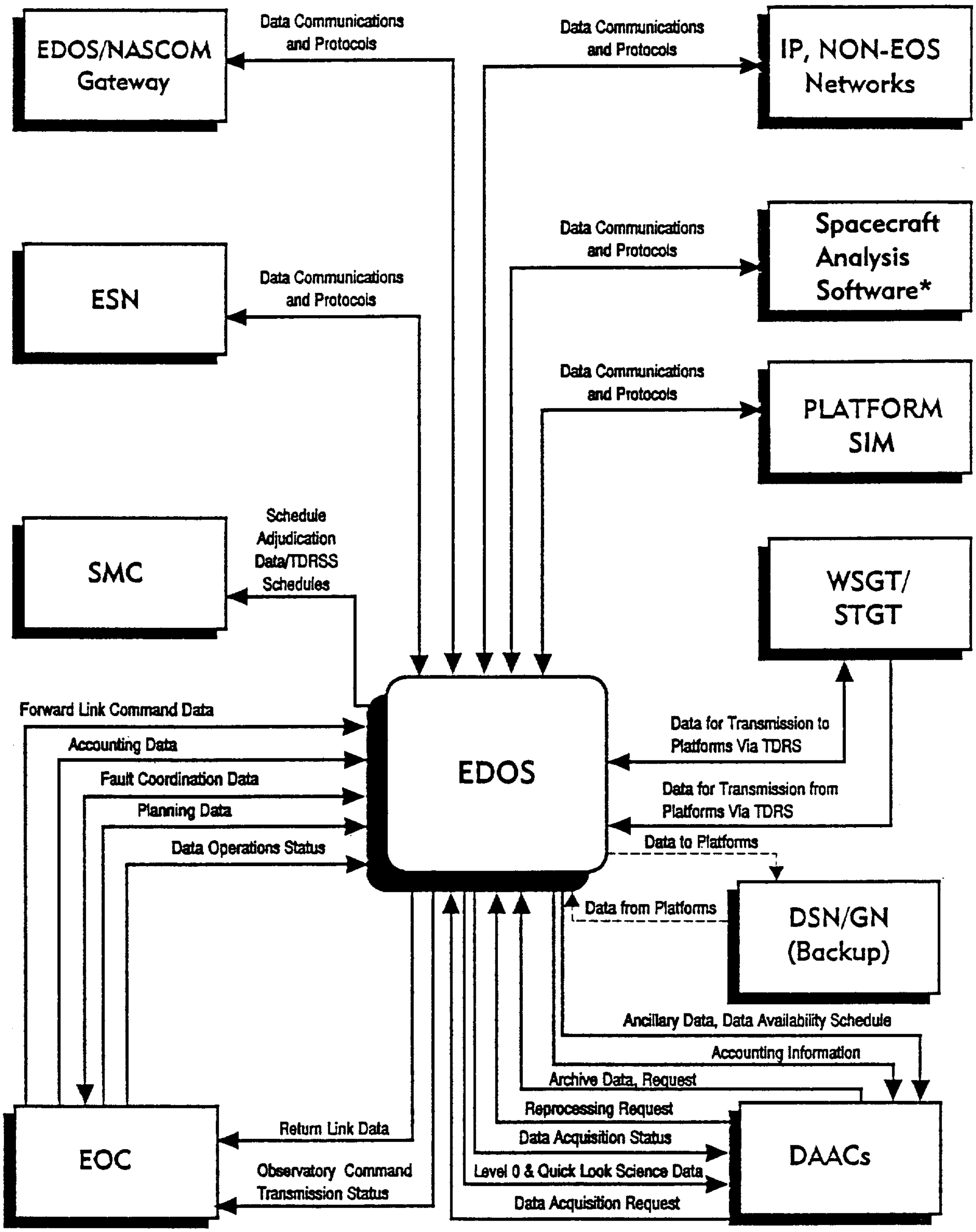


Figure 2.2.4.1-1: EDOS Interfaces and Data Exchanges

* Spacecraft Analysis Algorithms and/or software to be provided by the Spacecraft contractor for hosting in the EOC

Table 2.2.4.1-1. Data Flow <u>into</u> EDOS

EOC:	Forward link command data; accounting and planning data; fault coordination data; data operations status
SMC:	Schedule adjudication data/TDRSS schedules
WSGT/STGT:	Data transmitted from the spacecrafts via TDRS/TDRS-II; status data
DSN/GN:	Alternate path - data transmitted from the spacecrafts without TDRS/TDRS-II
DAACs:	Data acquisition request; archive data request, reprocessing request
ESN:	Network operations related internetwork coordination messages exchanged between the ESN and EDOS
IP, Non-EOS Networks:	Network operations related internetwork coordination messages exchanged with the IP networks and other non-EOS networks and EDOS
ECOM/NASCOM Gateway:	Data communication and protocols(s) conversion
Code 421 Ground Elements:	Data communication and protocols(s) conversion

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Table 2.2.4.1-2. Data Flow <u>out of</u> EDOS

EOC:	Return link data, fault coordination data, spacecraft command transmission status
SMC:	Schedule adjudication data
WSGT/STGT:	Data for transmission to spacecrafts via TDRS/TDRS-II
DSN/GN:	Alternate path - data to be transmitted to spacecrafts without TDRS/TDRS-II
DAACs:	Level 0 and quick look science data; ancillary data; data availability schedule; data acquisition status; accounting information
ESN:	Network operations related internetwork coordination messages exchanged between the ESN and EDOS
IP, Non-EOS Networks:	Network operations related internetwork coordination messages exchanged with IP networks and other non-EOS networks and EDOS
All Elements:	Data to be delivered to other elements
ECOM/NASCOM Gateway:	Data communication and protocols(s) conversion
Code 421 Ground Elements:	Data communication and protocols(s) conversion

2.2.4.2 ECOM/NASCOM Gateway

ECOM/NASCOM Gateway Location

The ECOM/NASCOM Gateway will be located at White Sands, New Mexico.

ECOM/NASCOM Gateway Functions/Services

The primary functions of the ECOM/NASCOM Gateway are to provide data communications, routing, switching functions as well as necessary protocol conversions.

ECOM/NASCOM Gateway Interfaces, Inputs, and Outputs

This gateway provides all necessary communications interfaces between EDOS and various other elements of EOS ground system for EOS uplink and downlink communications. The inputs into the gateway and outputs out of the gateway represent various uplink and downlink data between the EOS ground system and the EOS spacecrafts.

2.3 SPACECRAFT GROUND SUPPORT COMPONENT

2.3.1 Spacecraft Ground Support Component Relationship to Other Components

The relationship of the Spacecraft Ground Support Component to the other ground system components is shown in Figure 2.3.1-1.

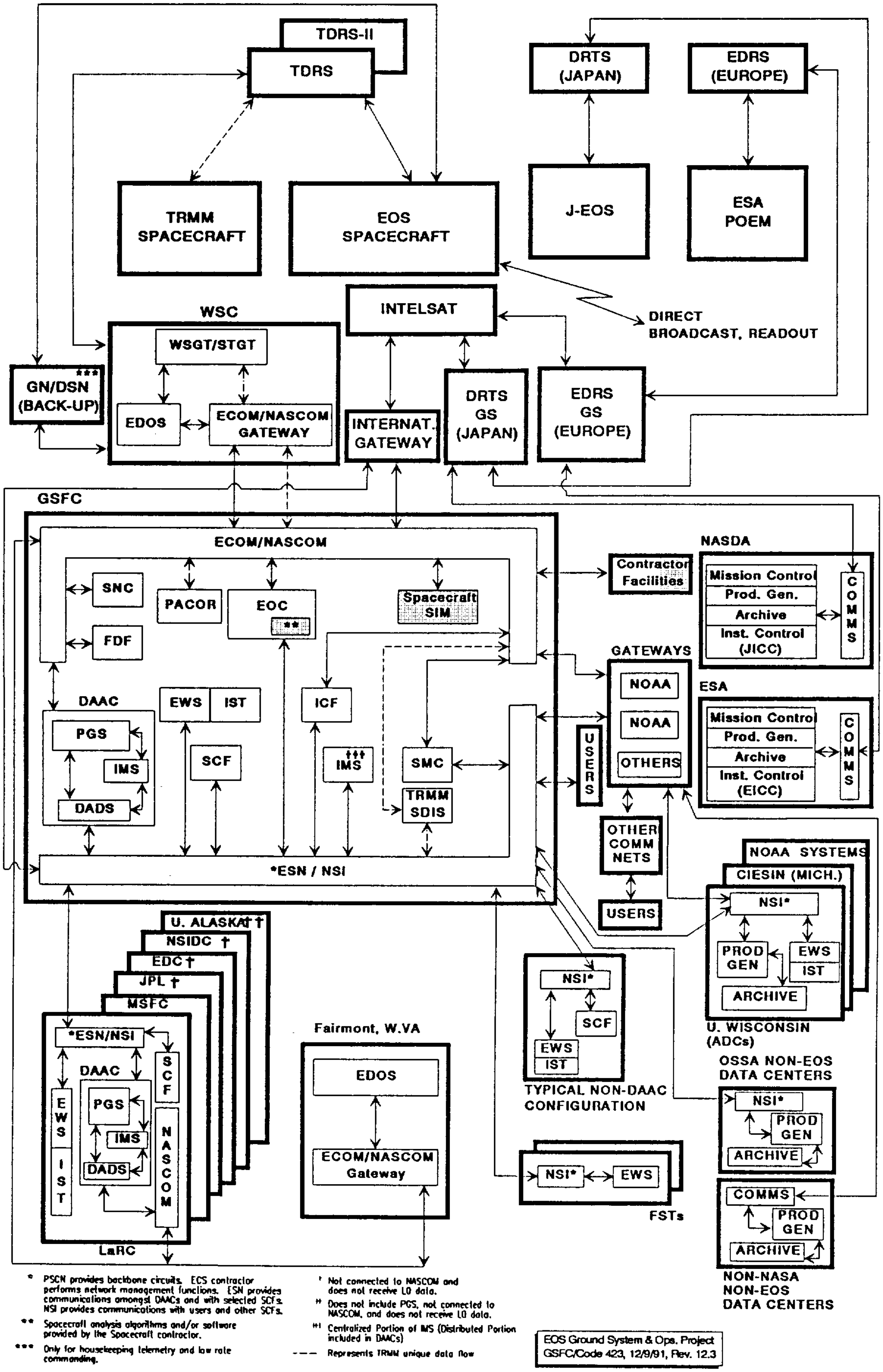

Figure 2.3.1-1. Spacecraft Ground System Component in the Context of the EOS Ground System

2.3.2 Spacecraft Ground Support Component Services

The Spacecraft Ground Support Component consists of two elements:

1) Spacecraft Analysis Software
2) Spacecraft Simulation (Spacecraft SIM)

These elements support development of the EOS spacecrafts.

2.3.3 Spacecraft Ground Support Component Interfaces and Data Flows

The Spacecraft Ground Support Component interfaces and primary data flows are shown in Figure 2.3.3-1.

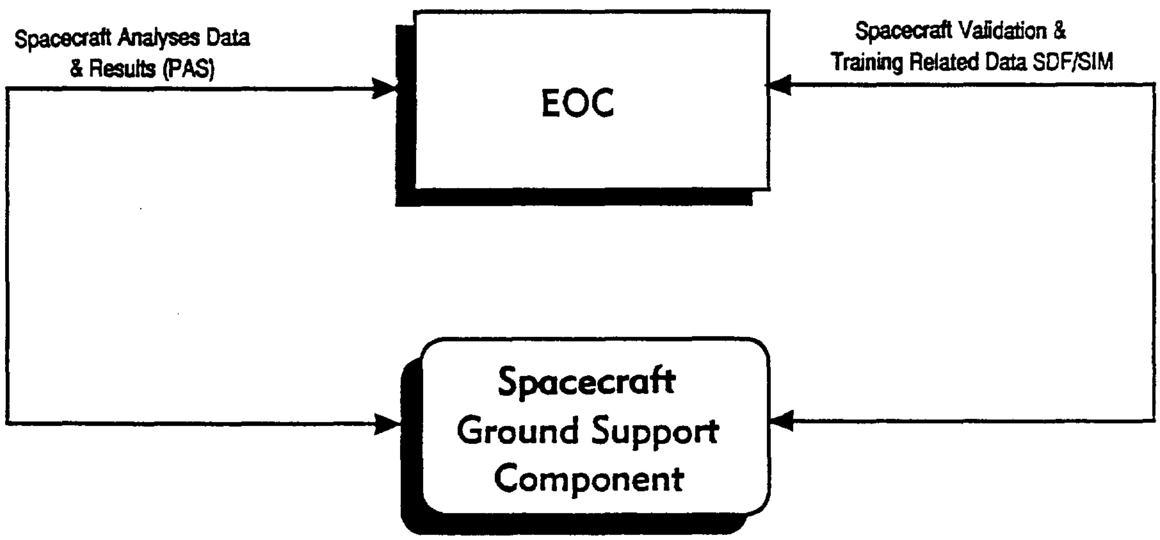

Figure 2.3.3-1. Spacecraft Ground Support Component Interfaces and Data Exchanges

2.3.4 Spacecraft Ground Support Element Descriptions

2.3.4.1 Spacecraft Analysis Software

Spacecraft Analysis Software Location

The Spacecraft Analysis Software is located in the EOC at GSFC.

Spacecraft Analysis Software Services/Functions

The Spacecraft Analysis Software is a software toolset which provides flight performance evaluation functions for the EOS spacecrafts. These functions include analyzing spacecraft performance trends, detecting incipient failures, and evaluating subsystem performance. The spacecraft analysis algorithms/software will be provided by the Spacecraft contractor.

The Spacecraft Analysis Software provides anomaly resolution support to the EOS Flight Operations Team by analyzing failures, evaluating solutions, validating procedures, reconstructing and simulating failure scenarios, and supporting anomaly diagnosis and resolution. Additional EOS operations support capabilities include compatibility analyses, hosting the EOS operations data base (e.g. telemetry calibration, operating modes), on-call engineering support during launch and on orbit check-out.

Spacecraft Analysis Software Interfaces, Inputs, and Outputs

The interfaces to the Spacecraft Analysis Software and the type of data transmitted between the interfacing elements are shown in Figure 2.3.4.1-1.

The types of data flowing into and out of the Spacecraft Analysis Software are listed in Tables 2.3.4.1-1. and 2.3.4.1-2.

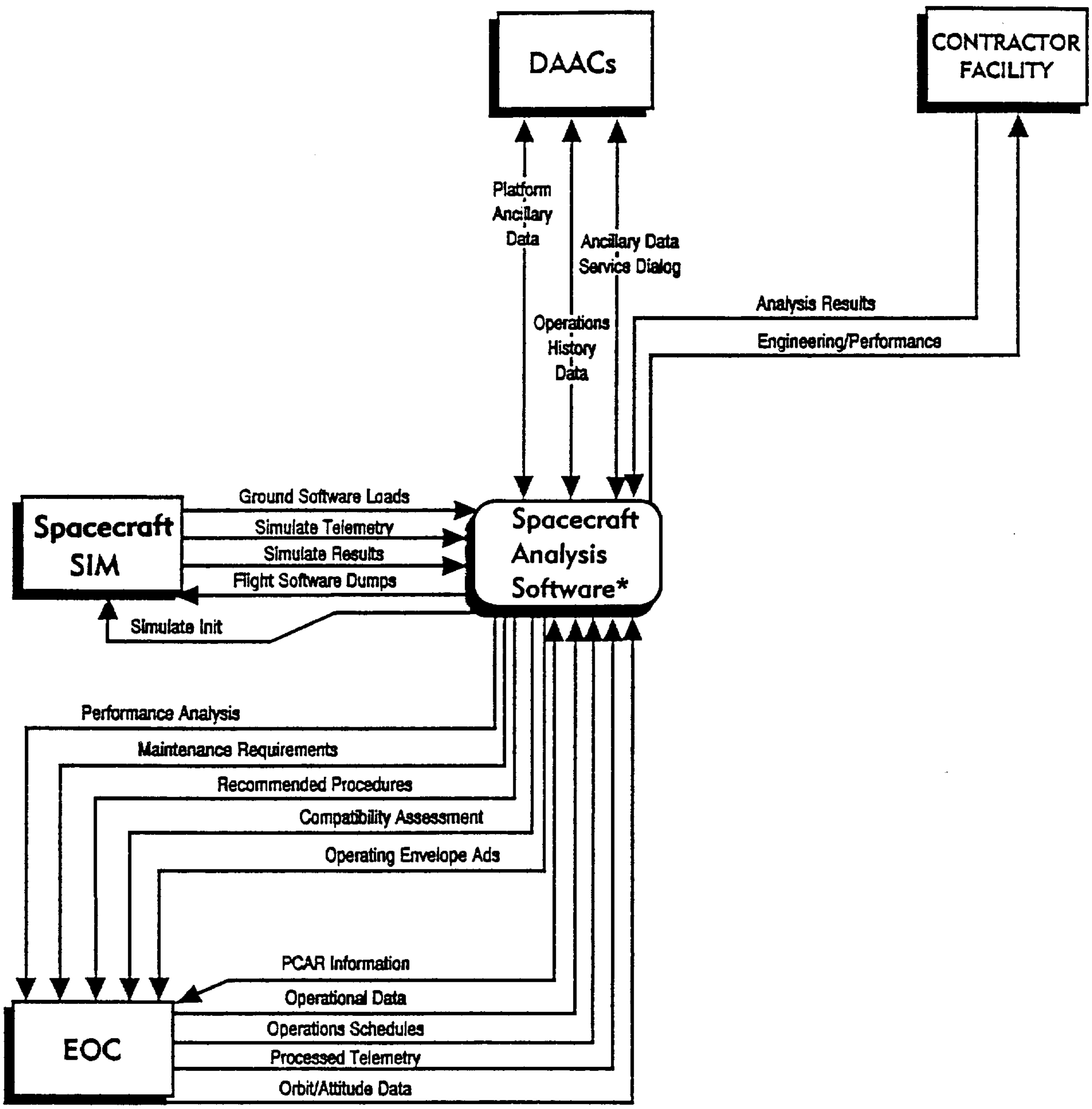

Figure 2.3.4.1-1. Spacecraft Analysis Software Interfaces and Data Exchanges

* Spacecraft Analysis Algorithms and/or software to be provided by the Spacecraft contractor for hosting in the EOC

Table 2.3.4.1-1. Data Flow **into** the Spacecraft Analysis Software

Spacecraft SIM:	Flight software fault analysis results; flight software configuration history data; C&DH Simulator test data output supporting fault isolation and analysis
EOC:	Core flight system monitoring, flight system performance evaluation and resource utilization results; core operations history, Spacecraft command history and performance evaluation results; procedure and document update requirements; data base updates definition required as a result of corrective action determination, optimization analyses, enhancement identification or other activities support requests; data base updates validation results notification; core systems and joint procedure and document update requirements identification support requests; on-orbit configuration data and core flight operations support system configuration data; Spacecraft orbit and attitude systems incipient or actual faults detected notice; orbit and attitude performance evaluation results; Guidance, Navigation and Control subsystem performance assessment requests
Contractor Facility:	Flight system design evaluation results, recommended enhancements, operations optimization support, fault isolation, fault analysis and corrective measure definition; initial, test core and instrument configurations; configuration history
DAACs:	Ancillary data service dialog; operations history data from DADs, spacecraft ancillary data

---

Table 2.3.4.1-2. Data Flow <u>out of</u> the Spacecraft Analysis Software

Spacecraft SIM:	Flight software and non-operational parameter modifications exchanged during the course of design and development that supports software maintenance
EOC:	Core flight system monitoring, flight system performance evaluation and resource utilization exchange; operational parameter and data base modification requirements; data base update requirements and definitions; procedure and document update requirements identification support; documents ready for configuration updates; detected Spacecraft system faults; on-orbit configuration management support; recommended contingency procedures; performance assessment or fault analysis results; fault isolation or performance assessment support requests; engineering and archive data
Contractor Facility:	Flight system design evaluation data; fault isolation and analysis support; core software modification requirements
DAACs:	Ancillary data service dialog; spacecraft ancillary data; operations history data to DADs

2.3.4.2 Spacecraft Simulation (Spacecraft SIM)

Spacecraft SIM Location

The Spacecraft SIM is located at GSFC.

Spacecraft SIM Functions/Services

The Spacecraft SIM provides ground-based simulation capabilities of the EOS-A1 Command and Data Handling (C&DH) subsystem. The simulation capabilities support EOS ground system test and training activities and includes support for training control center operators, testing operational procedures and spacecraft anomaly solutions, supports verification of end-to-end ground systems interfaces and hosts spacecraft mission and simulation software.

The Spacecraft SIM provides support to the EOS spacecraft verification and validation (IV&V) functions. IV&V functions include software validation and verification, ground and flight software testing, maintenance of spacecraft software loads and flight simulation.

Spacecraft SIM Interfaces, Inputs, and Outputs

The interfaces to the Spacecraft SIM and the type of data transmitted between the interfacing elements are shown in Figure 2.3.4.2-1. The types of data flowing into and out of the Spacecraft SIM are listed in Tables 2.3.4.2-1. and 2.3.4.2-2.

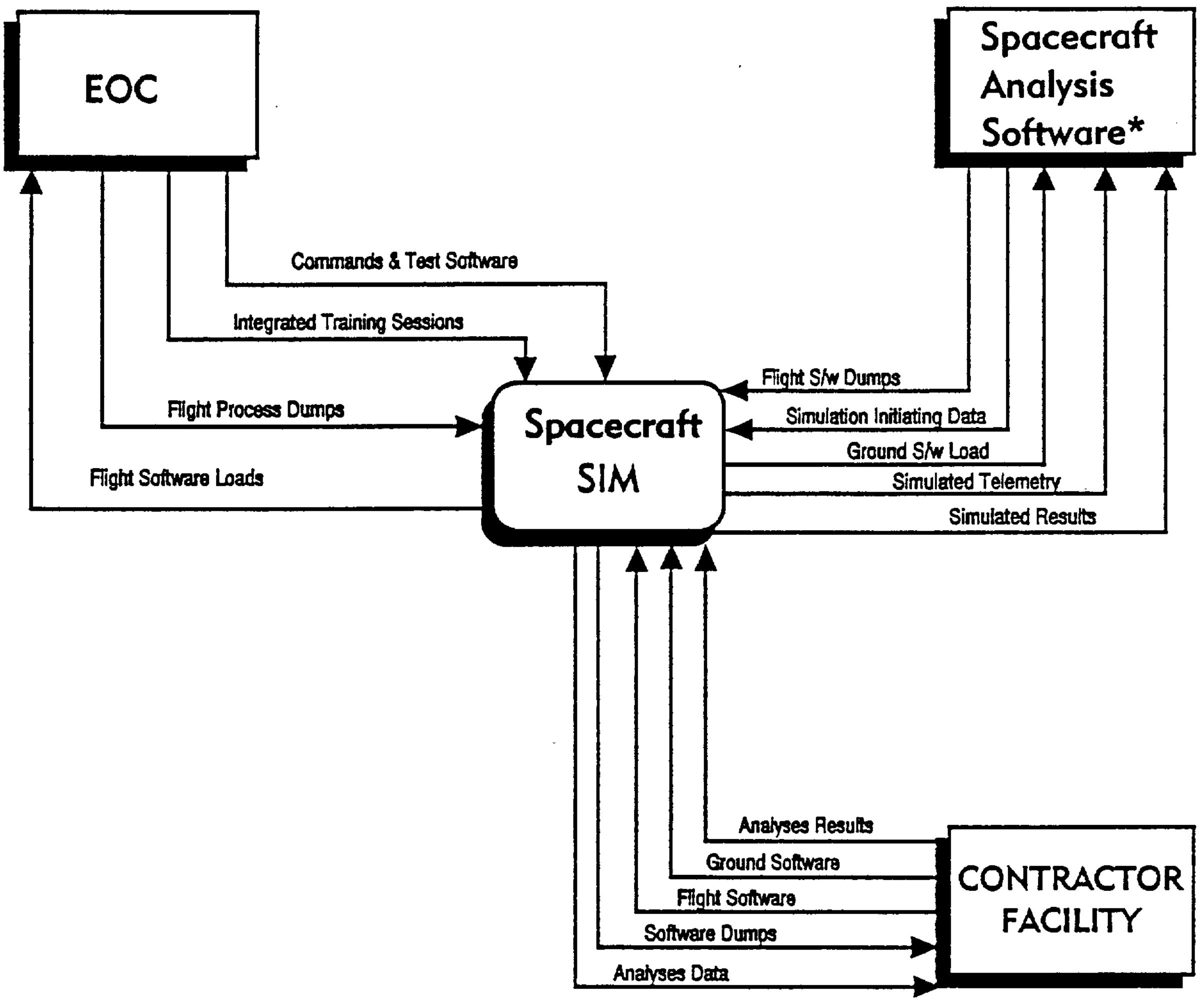

Figure 2.3.4.2-1. Spacecraft SIM Interfaces and Data Exchanges

* Spacecraft Analysis Algorithms and/or software to be provided by the Spacecraft contractor for hosting in the EOC

Table 2.3.4.2-1. Data Flow <u>into</u> the Spacecraft SIM

EOC:	Core and instrument commands; contingency procedures requiring validation; configuration data for updating flight software history and ground image; database update operational verification support requests; modified procedures and operator training exercises/validation support requests; on-orbit configuration data
Spacecraft Analysis Software:	Flight software loads and patches; data sets and conditions for simulations
Contractor:	Flight and ground software versions; results from troubleshooting and other analyses

---

Table 2.3.4.2-2. Data Flow <u>out of</u> the Spacecraft SIM

EOC:	Validated contingency procedures; software operational validation support for operational validation; C&DH simulator, mission and simulation software, and resident flight software support; housekeeping, instrument engineering, and ancillary data corresponding to the commands received from the EOC; mission and simulation software, and resident flight software, generated by the C&DH simulator; test bed validated software modifications ready
Spacecraft Analysis Software:	Ground software for interface testing with flight software; Simulated telemetry and observation data
Contractor:	Software for enhancement and/or problem resolution; software test Facility results

2.4 SCIENCE INVESTIGATOR SUPPORT COMPONENT

The Science Investigator Support Component consists of the user facilities supporting the science investigators who perform research using the instrument data at various levels of processing, archived at the DAACs' DADS.

2.4.1 Science Investigator Support Component Relationship to Other Components

The relationship of the Science Investigator Support Component to the other ground system components is shown in Figure 2.4.1-1.

The EOSDIS user community includes the following three major categories of users:

1) EOS investigators
2) non-EOS affiliated science users
3) other users

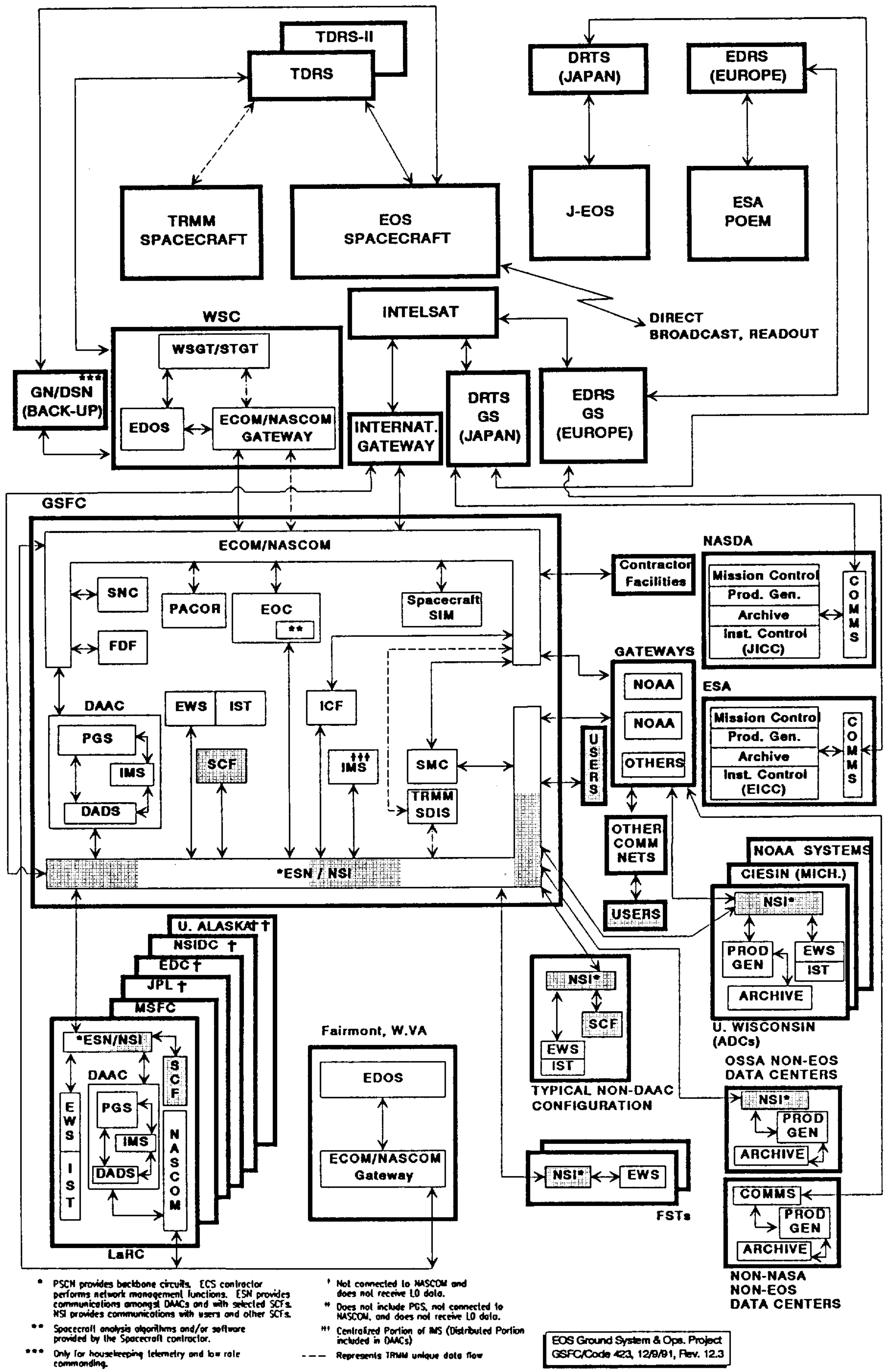

Figure 2.4.1-1. Science Investigator Support Component in the Context of the EOS Ground System

EOS Investigators

There are three types of EOS science investigators:

1) Instrument Investigators (a single Principal Investigator (PI) plus Co-Investigators (Co-Is)
2) Research Facility Instrument Teams (a single Team Leader (TL) plus Team Members (Tms)
3) Interdisciplinary Investigators (a single PI and Co-Is)

Within the user community there are two major orientations, the Instrument oriented User and the Discipline oriented User. The Discipline oriented user is usually a remote sensing scientist concerned with how best to use the data from a given instrument to learn more about the environment. This User will be particularly interested in how best to calibrate *his* instrument and validate its data products. The Discipline oriented User will usually be a PI, Co-I, or TM associated with an interdiscipling science team. His interest is more likely to involve use of data from multiple instruments to tackle a science problem. Instrument oriented investigators are likely to be data producers; Discipline oriented investigators are likely to be data users.

Non-EOS Affiliated Science Users

The user community extends past the boundary of mission-selected research scientists (the PI, Co-I, and TL/TM) associated with a particular instrument or research investigation. EOS data and information will be used by the broader operational and research communities, including such groups as U.S. and international operational agencies and international Earth science research community at academic and government institutions. Researchers at academic and governmental institutions who are not affiliated with the EOS Program will be able to access the EOSDIS catalogs and order EOS products. In particular, the EOS data system will provide access to data for research programs of other U. S. Government agencies (e.g., USGS, NOAA, and the National Forest Service).

Other Users

Other users constitute a population with more diverse characteristics than the other two categories. These users can be further subdivided into the following groups:

1) Policy makers and implementers
2) EOSDIS and EOS managers
3) EOSDIS development and operations personnel
4) External system developers and tool developers
5) Small data set users

2.4.2 Science Investigator Support Services

The science investigators not only access data for use in their research, but are required to make the results of their investigations available to the rest of the user community in a timely fashion. This is accomplished by archiving their data at an associated DAAC and recording it at the IMS. Communication to and from the ECS elements is via the National Science Internet (NSI) connection to ESN.

2.4.3 Science Investigator Support Interfaces and Data Flows

The Science Investigator Support interfaces and data flows are shown in Figure 2.4.3-1.

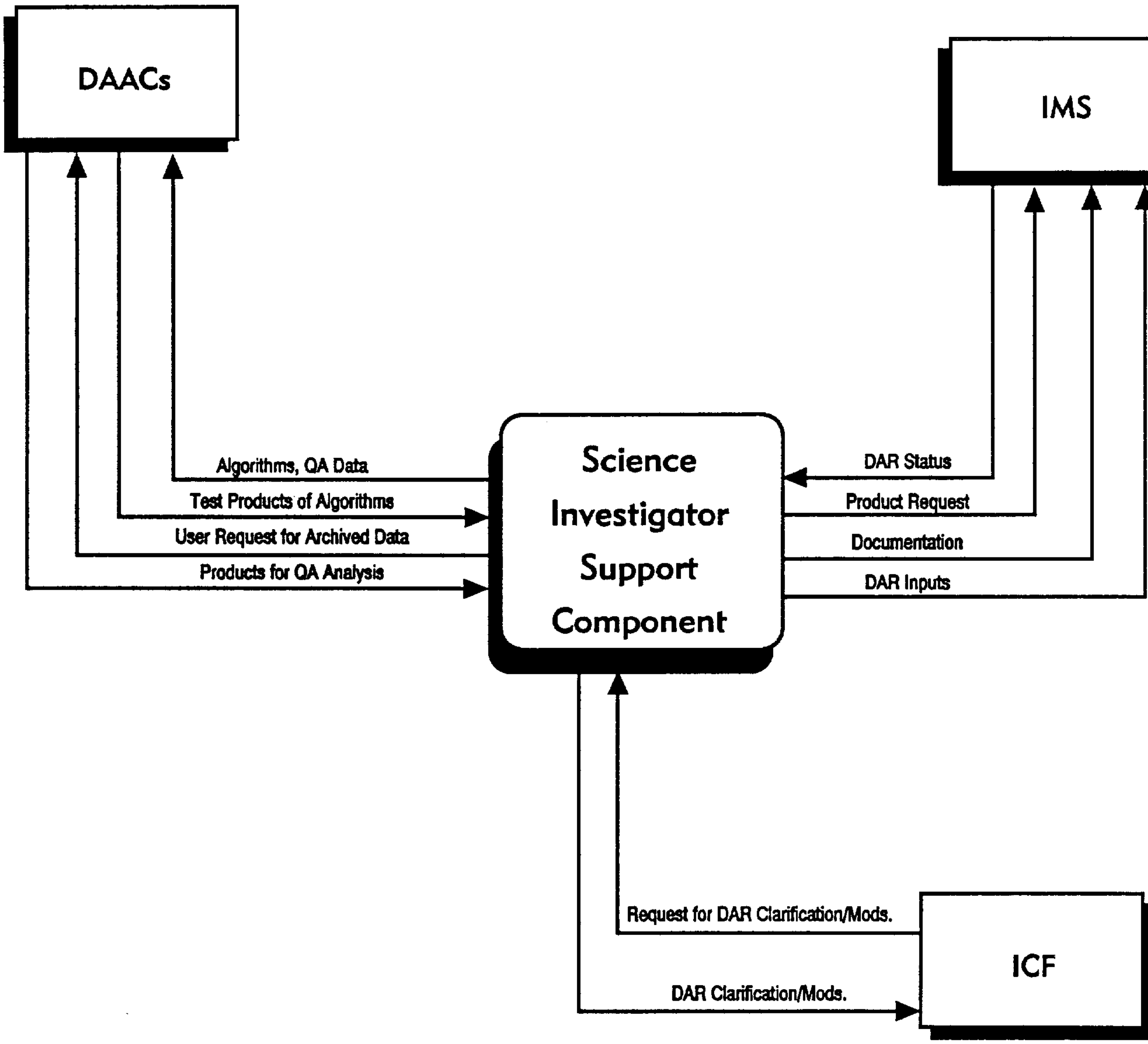

Figure 2.4.3-1: Science Investigator Support Component Interface and Data Exchanges

2.4.4 Science Investigator Support Element Descriptions

2.4.4.1 Science Computing Facility (SCF)

SCF Location

The SCFs are located at each PI, TL, TM, and II facility.

SCF Functions/Services

The EOS Project will fund Science Computing Facilities (SCF) for each PI, team leader and team member. NASA HQ will fund SCFs for interdisciplinary investigators in support of their research programs. Each SCF provides hardware and software resources for approved earth science researchers and investigators. All SCFs will aid Earth science investigators in science algorithm development and software maintenance. EOS ground systems support to each SCF includes software standards, tools and procedures. EOS ground system support to the SCF is provided by the ECS via software tools.

As investigator-developed software and algorithms mature, the ECS DAAC will manage the migration of the SCF developed algorithms into the production environment of the PGS supported by the IMS. To support development of NASA OSSA managed science algorithms and ease software migration and portability into the product generation environment, the EOS Program anticipates maturing of industry software standards, tools and practices. Following successful migration of instrument-specific algorithms into each DAAC, other SCF provided functions, such as instrument calibration, software quality control and support to DAAC product validation, will be phased into the ECS managed contractor facilities. From FY 90 through FY 91, NASA HQ plans include establishment of approximately fifty SCFs.

SCF Interfaces, Inputs, and Outputs

The interfaces to the SCF and the type of data transmitted between the interfacing elements are shown in Figure 2.4.4.1-1.

The types of data flowing into and out of the SCF are listed in Tables 2.4.4.1-1. and 2.4.4.1-2.

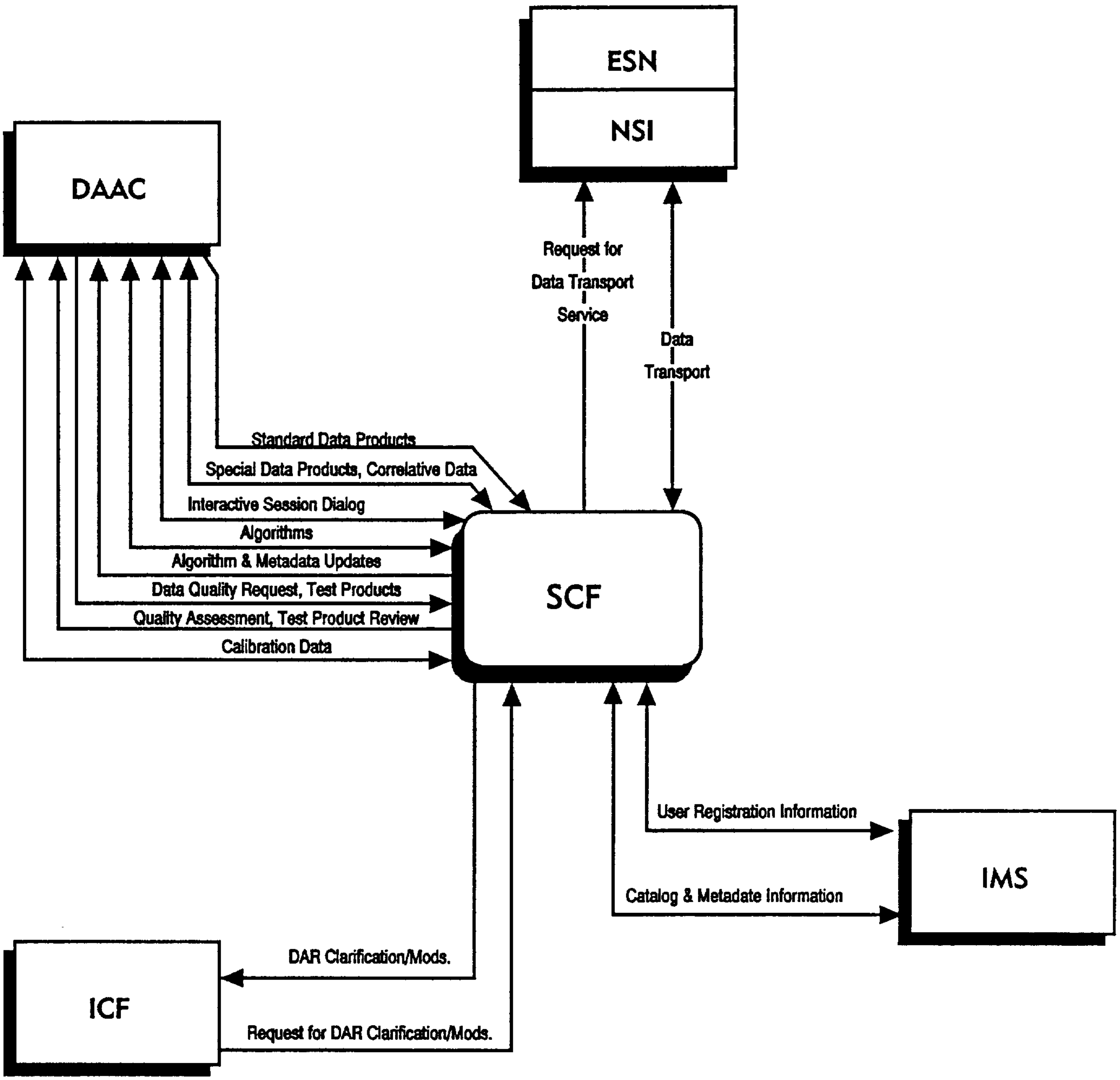

Figure 2.4.4.1-1: SCF Interfaces and Data Exchanges

Table 2.4.4.1-1. Data Flow **into** the SCF

DAACs:	Request for QA assessment; test products generated from algorithm evaluation; standard products; special products; correlative data, interactive session dialog, algorithms
ICF:	Request for DAR clarification and modifications
ESN:	Data transport services
IMS:	User registration information; catalog and metadata information

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Table 2.4.4.1-2. Data Flow **out of** the SCF

DAACs:	Requests for documents, associated data, and products; QA assessment information; special data products; correlative data, interactive session dialog, algorithm and metadata updates, test product review
ICF:	DAR clarifications and modifications
ESN:	Request for data transport services
IMS:	User registration information; catalog and metadata information

2.4.4.2 User Facilities

User Facility Locations

The User facilities are located at universities, data centers, and non-EOS government agencies.

User Facility Functions/Services

The user community is an important aspect of the total system because of the close user-system interactions which characterize EOSDIS. Users of EOSDIS data will interface with the system to share and exchange data and data information. EOSDIS users include those facilities and organizations participating directly in EOSDIS, other NASA data systems and archives, other government data systems and archives, university research programs, international investigators/data centers and commercial data systems.

The EOSDIS research community will include almost any institution, laboratory or university in the country, and potentially in the world, that supports work in the Earth sciences. The range of data required for these users will extend from short browse data sets to entire global data bases. Distribution will also be varied: electronic methods may serve for some data sets and data queries; however, express or regular mail shipment of data on tapes or optical disks will be more cost effective for larger data sets. The IMS provides the user access to the EOSDIS data bases through the use of standard and easy-to-use protocols, complete and up-to-date data inventories and directory listings, availability of appropriate browse data sets and timeliness od delivery.

User Facility Interfaces, Inputs, and Outputs

The User facility interfaces, inputs and outputs are the same as for the SCF as shown in Figure 2.4.4.1-1. and Tables 2.4.4.1-1. and 2.4.4.1-2.

2.5 DATA CENTERS COMPONENT

NASA operates one of the largest collections of environmental databases in the country. Many of these data systems may participate in the EOSDIS by providing their data processing and archive services. Such data systems include the National Climate Data System, and the Pilot Data Systems which comprise NASA-developed data systems in support of climatology, oceanography, and land use.

In addition to the NASA data centers, a number of institutional facilities will play a role in EOSDIS either by hosting a DAAC or serving as an Affiliated Data Center (ADC). ADCs will share data and results with the DAACs. Other Data Centers (ODCs) will provide access to existing Earth science databases and correlative data.

2.5.1 Data Centers Component Relationship to Other Components

The relationships of the Data Centers Component to the other ground system components is shown in Figure 2.5.1-1.

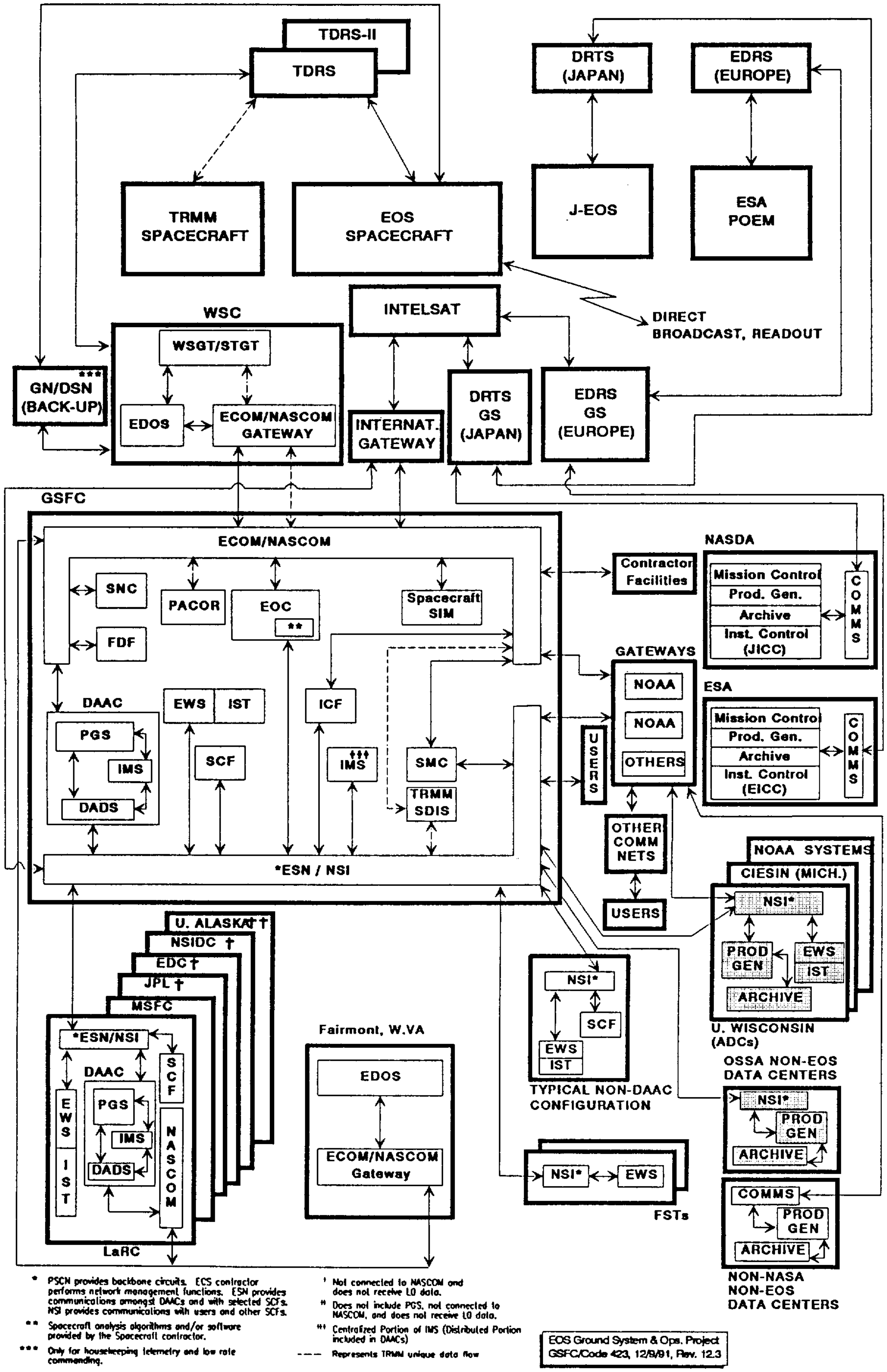


Figure 2.5.1-1: Affiliated Data Centers and Other U.S. Non-EOS Data Centers in the Context of the EOS Ground System

2.5.2 Data Centers Services

The Data Centers serve as the host for generating data products and archiving data associated with their discipline. The specific services are discussed in the element descriptions.

2.5.3 Data Centers Component Interfaces and Data Flows

The Data Centers Component interfaces and data flows are shown in Figure 2.5.3-1.

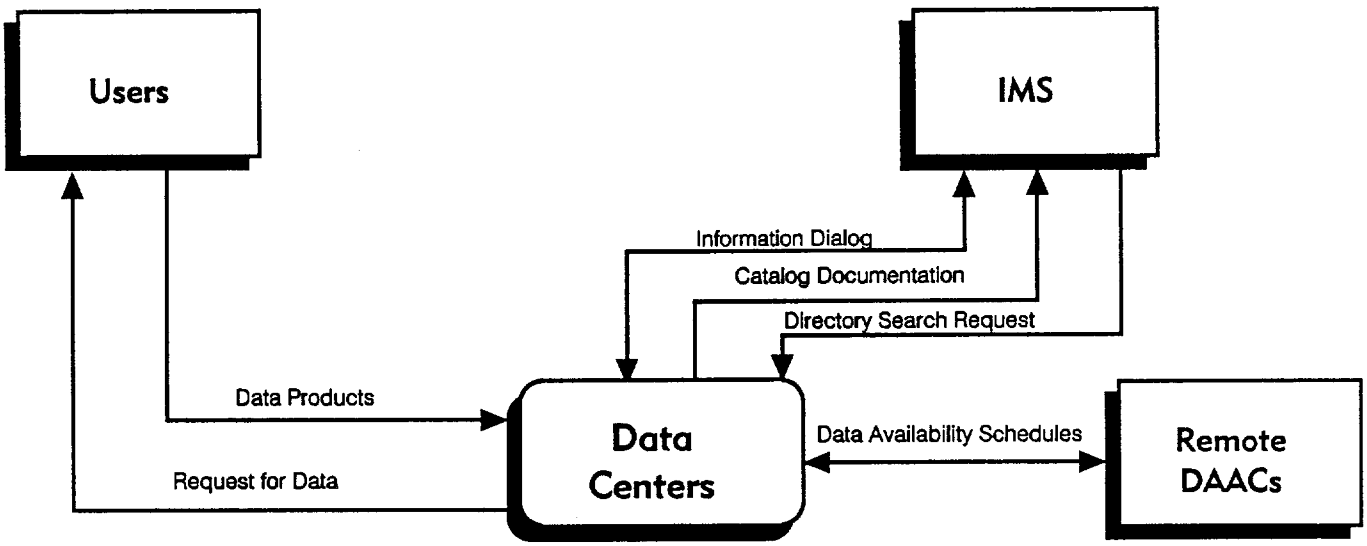


Figure 2.5.3-1: Data Center Component Interfaces and Data Exchanges

2.5.4 Data Centers Element Descriptions

2.5.4.1 DAACs

The DAACs are discussed as elements in the ECS Component section. Please refer to Paragraph 2.1.4.3.

2.5.4.2 Affiliated Data Centers (ADCs)

ADC Locations

The Affiliated Data Centers are located in the following locations:

National Oceanic & Atmospheric Administration ADCs
- National Environmental Satellite Data and Information Service (NESDIS)
  (one or more data systems affiliated with NESDIS)
- National Meteorological Center (NMC), Camp Springs, MD

University of Wisconsin, Madison, WI
Consortium for International Earth Science Information Network (CIESIN), MI

ADC Functions/Services

Each ADC provides data product production, archival, and distribution functions for non-EOS data. Each ADC supports global change research through study and research of applications oriented problems related to human survival, well-being, and public policy. Functionally, each ADC supports access to other EOSDIS DAAC's data archives support of global change research conducted in those institutions. The following paragraphs highlight each ADC scientific expertise.

2.5.4.2.1 NOAA ADCs

NOAA produces many atmospheric and oceanographic data sets and maintains a number of databases of key importance to the EOS research program. These include both Level 1 and derived geophysical products, some of which will be required on a routine basis to support the production or validation of EOS standard products. The NOAA organizations highlighted in the following sections produce or hold data and products of known or potential utility to the EOS program. An ADC at each organization may be the best mechanism for providing this linkage between the operational systems and EOS.

The functions of the NOAA ADCs are described below.

National Environmental satellite Data and Information Service (NESDIS)

NESDIS is responsible for the operation of geostationary and polar orbiting meteorological satellites. NESDIS centers can access EOS data and will provide data analyses reports back to the DAACs.

National Meteorological Center (NMC) in Camp Springs, MD

The NMC and its Climate Analysis Center (CAC) provide routine weather and climate forecasts for the U.S. These are produced by operation of large scale models which ingest data from a vast array of sources ranging from ground observations to satellites. The products are of critical importance to the Global Change Research Program (GCRP).

2.5.4.2.2 University of Wisconsin

The Space Science and Engineering Center (SSEC) of the University of Wisconsin maintains, under a NOAA contract, a long term archive and distribution function for Level 1 data from NOAA GOES environmental satellites. In addition the SSEC acts as a Science Computing Facility (SCF), developing and testing algorithms and generating higher level atmospheric products from GOES data. EOSDIS will provide an interface to SSEC's on-line GOES inventory and data ordering system, allowing EOSDIS users to search for and request off line delivery of GOES data.

2.5.4.2.3 Consortium for International Earth Science Information Network (CIESIN)

The primary role of the ADC at CIESIN is to make data within EOSDIS more accessible to applied users and policy makers. It will provide to non-research users, ranging from government decision makers, environmentalists and farmers, an understanding of EOS and a capability to effectively use EOSDIS. The CIESIN serves the EOS research community for databases derived from policy formulation and other applied activities. The data centers associated with CIESIN include Saginaw Valley State College (SVSC), University of Michigan and Environmental Research Institute of Michigan (ERIM).

2.5.4.3 Non-NASA, Non-EOS Data Centers

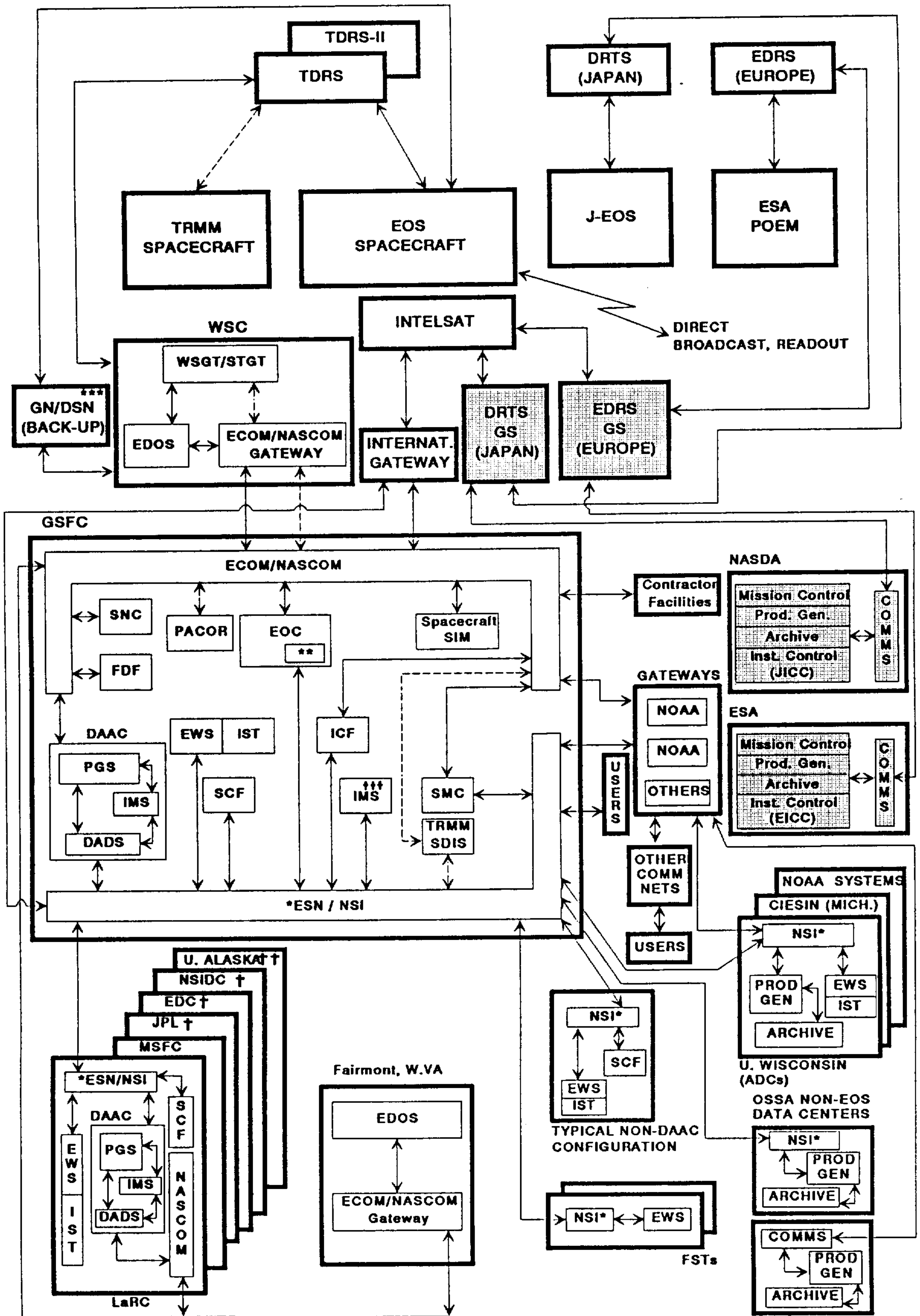
TBD

2.6 INTERNATIONAL GROUND SYSTEMS COMPONENT

The International participants, ESA and NASDA/MITI, provide data acquisition, processing, archiving, and distribution capabilities in support of their spacecrafts, instrument payloads, and satellite communications relay. Each participant will have a ground system similar to the EOSDIS command and data processing and distribution centers. Data will be exchanged via gateways between the IP's ground centers and EDOS.

2.6.1 International Ground Systems Relationship to Other Components

The relationship of the International Ground Systems Component to Other Components is shown in Figure 2.6.1-1.



* PSCN provides backbone circuits. ECS contractor performs network management functions. ESN provides communications amongst DAACs and with selected SCFs. NSI provides communications with users and other SCFs.

** Spacecraft analysis algorithms and/or software provided by the Spacecraft contractor.

*** Only for housekeeping telemetry and low rate commanding.

† Not connected to NASCOM and does not receive L0 data.

†† Does not include PGS, not connected to NASCOM, and does not receive L0 data.

††† Centralized Portion of IMS (Distributed Portion included in DAACs)

--- Represents TRMM unique data flow

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Figure 2.6.1-1: International Ground Systems Component in the Context of the EOS Ground System

2.6.2 International Ground Systems Services

The International Ground System will provide for the exchange of spacecraft and payload data from the IPs ground system. All agencies will exchange data and will support planning and scheduling, commanding, and operations of instruments on their respective spacecrafts. Instruments from several countries are expected to be carried by U.S. spacecrafts, requiring commanding support as well as data processing and exchange services. U.S. participants will require data from international payloads on any of the spacecrafts and the international participants will require access to U.S. payload data for their processing and/or investigations. The ECS will provide for the exchange of data between the U.S. and the international databases.

2.6.3 International Ground Systems Interfaces and Data Flows

The International Ground Systems interfaces and data flows are shown in Figure 2.6.3-1.

2.6.4 International Ground Systems Element Descriptions

The EOS international participants' (IP) ground system will provide functions such as mission operations, data processing and archiving, and communications services similar to those functions provided by the EOC, DAACs, ICF, and ESN. The interface between the IPs and the EOS program will be defined by a HQ Memorandum of Understanding (MOU).

2.6.4.1 European Space Agency (ESA) Ground System

To be provided when available.

2.6.4.2 National Space Development Agency (NASDA - Japan)/Ministry of International Trade and Industry (MITI)

To be provided when available.

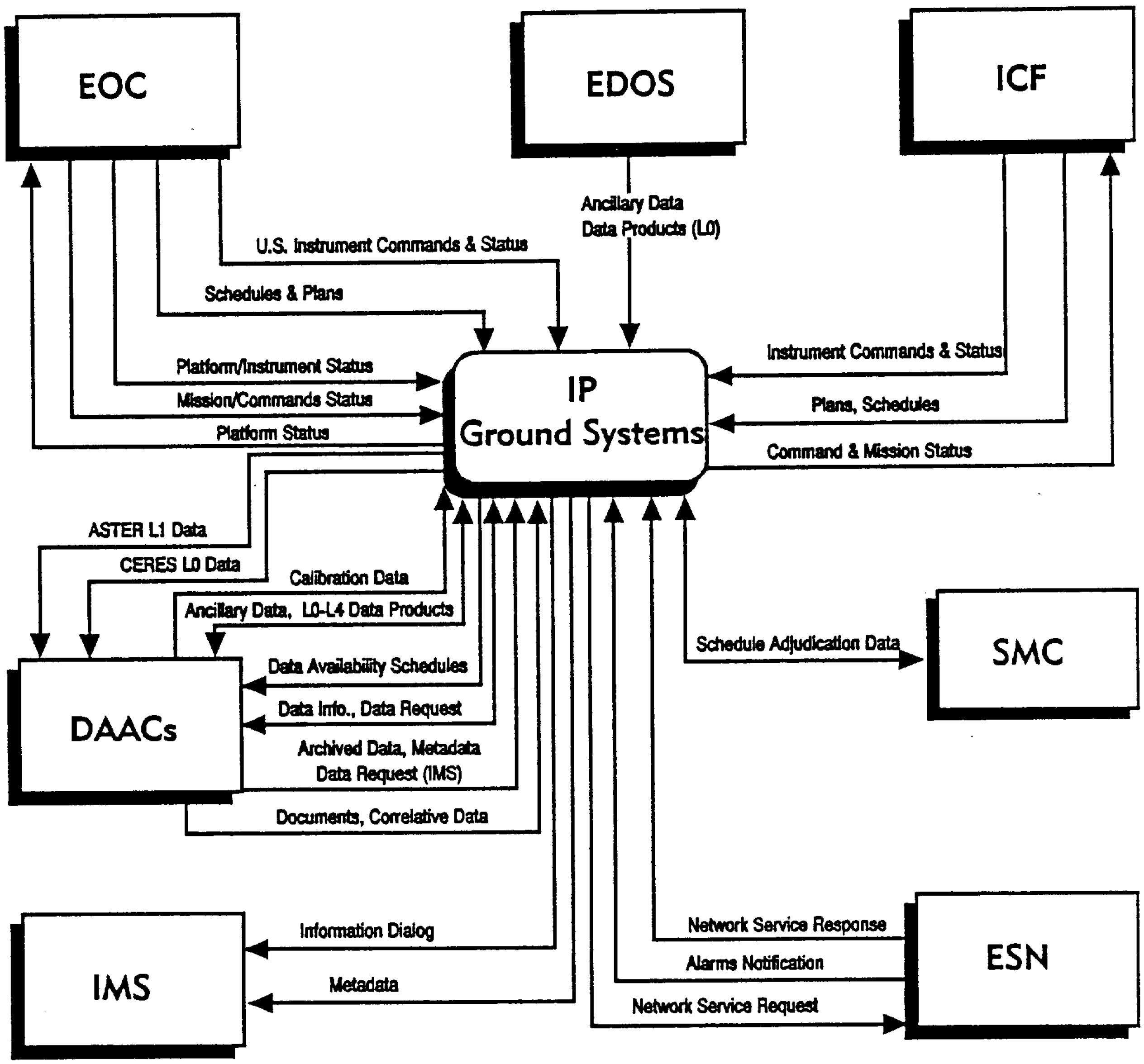


Figure 2.6.3-1: International Ground Systems Interfaces and Data Exchanges

2.7 TRMM GROUND SUPPORT COMPONENT

The Tropical Rainfall Measuring Mission (TRMM) ground support component provides data collection and analysis services for the TRMM project.

2.7.1 TRMM Ground Support Component Relationship to Other Ground System Components

Figure 2.7.1-1 shows the relationship of the TRMM Ground Support Component to the rest of the EOS ground system.

2.7.2 TRMM Ground Support Services

The TRMM ground support facilities provide data collection, archive, and distribution services for the five instruments on-board the TRMM spacecraft. These instruments are:

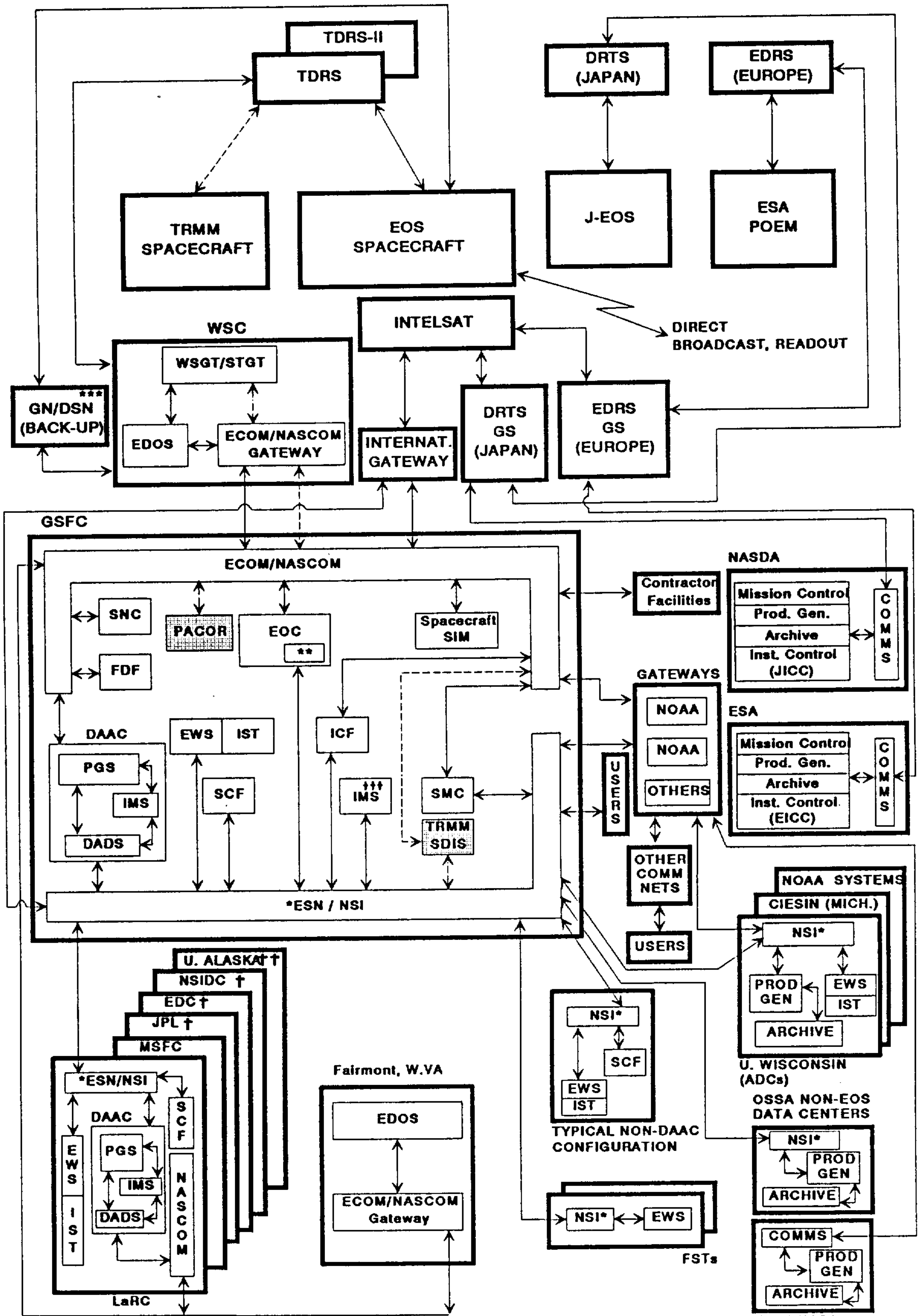
CERES	Cloud and Earth Radiant Energy System
LIS	Lightning Imaging Sounder
PR	Precipitation Radar
TMI	TRMM Microwave Imager
VIRS	Visible Infrared Scanner

2.7.3 TRMM Ground Support Services Interfaces

Figure 2.7.3-1 shows the TRMM ground support services interfaces to the rest of the ground system, and the high level data flows between them.

2.7.4 TRMM Ground Support Services Elements

The TRMM ground support services are provided by two elements, the Packet Processor (PACOR) Data Capture Facility (DCF), and the TRMM Science Data and Information System (TSDIS) which consists of two facilities, the Science Data Analysis Center (SDAC) and the Science Operations and Control Center (SOCC).



* PSCN provides backbone circuits. ECS contractor performs network management functions. ESN provides communications amongst DAACs and with selected SCFs. NSI provides communications with users and other SCFs.

** Spacecraft analysis algorithms and/or software provided by the Spacecraft contractor.

*** Only for housekeeping telemetry and low rate commanding.

† Not connected to NASCOM and does not receive L0 data.

†† Does not include PGS, not connected to NASCOM, and does not receive L0 data.

††† Centralized Portion of IMS (Distributed Portion included in DAACs)

- - - Represents TRMM unique data flow

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GSFC/Code 423, 12/9/91, Rev. 12.3

Figure 2.7.1-1: TRMM Ground SystemFacilities Component in the Context of the EOS Ground System

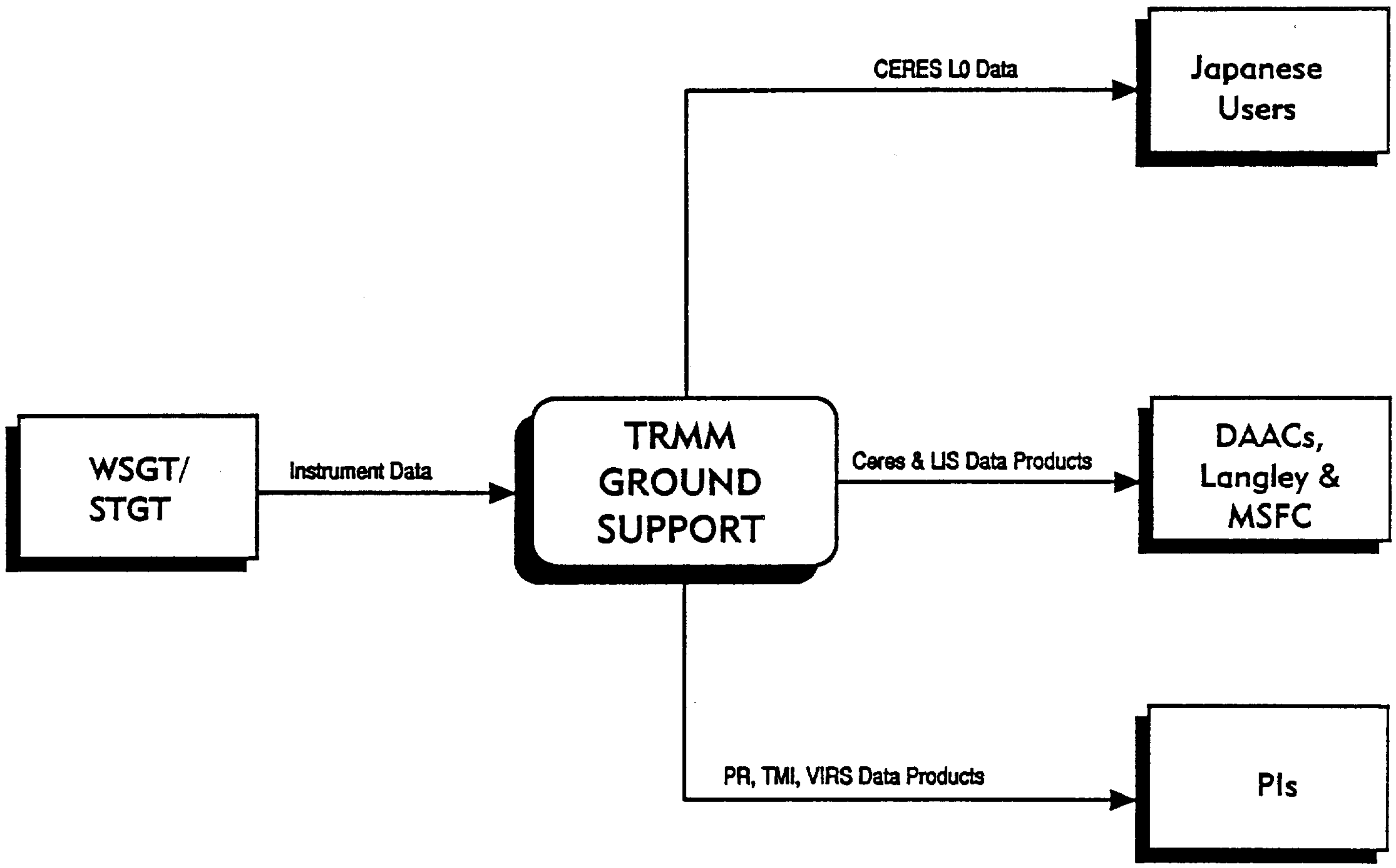

Figure 2.7.3-1: TRMM Ground Support Interfaces and Data Exchanges

2.7.4.1 TRMM Packet Processor (PACOR) Data Capture Facility (DCF)

PACOR Location

The ground facility for capturing Tropical Rainfall Measuring Mission (TRMM) data is the Packet Processor Data Capture Facility (PACOR DCF) which is a multi-project facility located at GSFC.

PACOR Functions/Services

The PACOR DCF is a Level 0 ground system designed to capture and process packet telemetry data that adhere to packet forms prescribed by the PACOR Project. The PACOR DCF performs the following functions:

- Data capture
- Transfer frame extraction from the communications blocks
- Transfer frame synchronization
- Data correction processing (Reed-Solomon decoding)
- Checking of frame cyclical redundancy code (RC), if present
- Separation of virtual channels
- Packet reassembly
- Logging of received playback transfer frames to magnetic media
- Reversal of playback data
- Grouping of data sets for users
- Optional merging of real-time and playback data
- Optional deletion of redundant data
- Error checking
- Quality and accounting data generation
- Store and forward prepared data sets to users via electronic transmission or magnetic media

Special communications controllers accept schedule data input from the SNC, and are used to output post-event reports back to the SNC within minutes after the completion of spacecraft data input from EDOS. The PACOR DCF may also receive recovery data from the WSGT through the EDOS interface.

The TRMM science data receives Level 0 processing at the DCF and then for L1 through L4 processing it is forwarded to a data analysis & archive facility depending on the instrument from which the data was generated.

Instrument	Processing Facility
CERES	Langley DAAC
LIS	MSFC DAAC
PR	TSDIS
TMI	TSDIS
VIRS	TSDIS

PACOR Interfaces, Inputs and Outputs

The interfaces to the PACOR DCF and the types of data transmitted between the interfacing elements are shown in Figure 2.7.4.1-1.

A definition of the types of data flowing into and out of the PACOR DCF are listed in Tables 2.7.4.1-1 and 2.7.4.1-2.

Table 2.7.4.1-1.	Data Flow <u>into</u> the PACOR DCF
WSGT/STGT:	Instrument science data; instrument health data; spacecraft housekeeping data

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Table 2.7.4.1-2.	Data Flow <u>out of</u> the PACOR DCF
TRMM SDIS:	Instrument monitoring data Level 0 instrument data for the PR, TMI, and VIRS instruments
DAAC, Langley:	Level 0 instrument data for the CERES instrument
DAAC, MSFC:	Level 0 instrument data for the LIS instrument
Japanese Users:	Level 0 science and housekeeping data for the CERES instrument

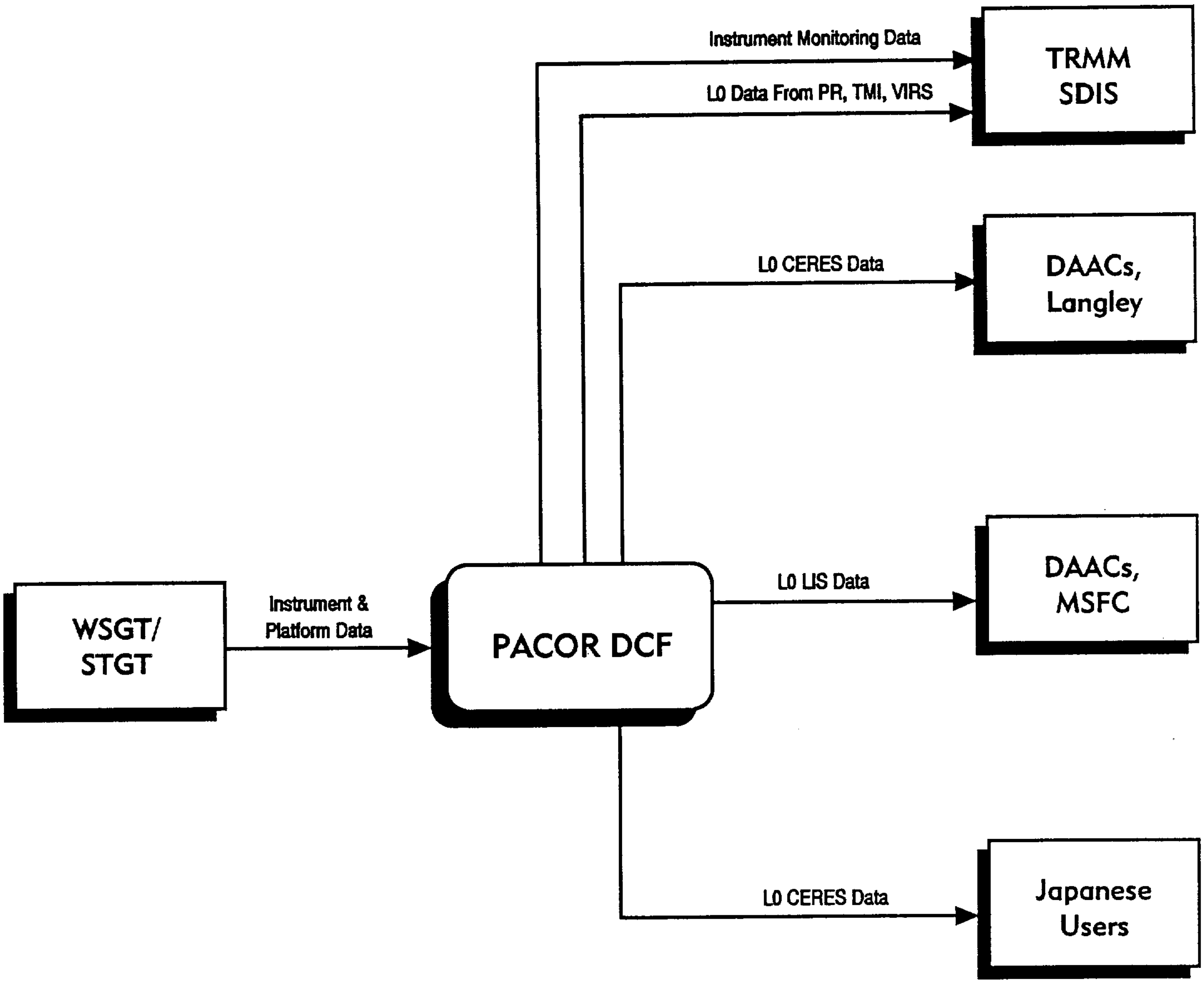

Figure 2.7.4.1-1: PACOR DCF Interfaces and Data Exchanges

2.7.4.2 TRMM Science Data and Information System (TSDIS)

TRMM SDIS Location

The TSDIS is located at GSFC.

TRMM SDIS Services/Functions

The TSDIS is responsible for science planning and instrument monitoring coordination. It is responsible for higher level processing of production data products. Ancillary ground truth data and data from supporting field experiments required for data processing and validation will be stored at the TSDIS. Data products generated by the TSDIS will be available to TRMM scientists via the NASA Science Internet (NSI).

The TSDIS forwards data products to the PIs as requested or predefined, and after release approval by the TRMM Science Team, to the appropriate DAACS for archiving and subsequent distribution to general users.

TRMM SDIS Interfaces, Inputs, and Outputs

The interfaces to the TSDIS and the types of data transmitted between the interfacing elements are shown in Figure 2.7.4.2-1.

A definition of the types of data flowing into and out of the TSDIS are listed in Tables 2.7.4.2-1 and 2.7.4.2-2.

Table 2.7.4.2-1. Data Flow <u>into</u> the TSDIS

PACOR DCF:	Instrument monitoring data PR, TMI, VIRS instruments L0 data
PIs:	Approved L1-L4 PR, TMI, VIRS data products

Table 2.7.4.2-2. Data Flow <u>out of</u> the TSDIS

PIs:	PR, TMI, and VIRS instruments L1-L4 data products for approval

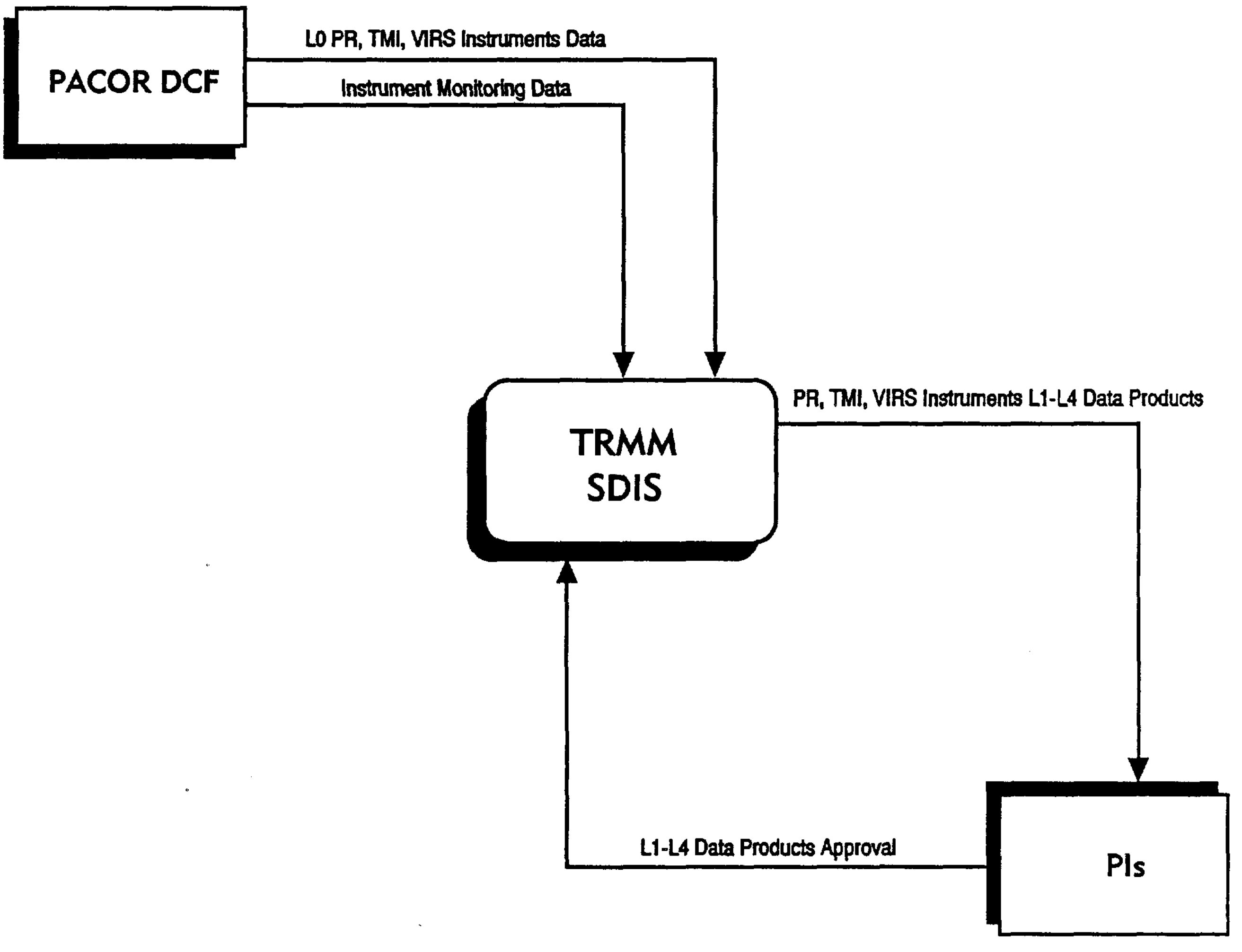

Figure 2.7.4.2-1: TRMM SDIS Interfaces and Data Exchanges

2.8 EOS CONTRACTOR FACILITIES COMPONENT

The EOS Contractor Facilities Component consists of the development and support facilities of the EOS contractors. To date, there is one contract, the Spacecraft contract being performed by General Electric. The up-coming contracts are the ECS contract and the EOS Ground System IV&V contract.

2.8.1 EOS Contractor Component Relationship to Other Components.

The relationship of the EOS contractor facilities to other components is shown in Figure 2.8.1-1.

2.8.2 EOS Contractor Facility Services

The EOS contractor facilities will be used to support the development and maintenance of EOS products.

2.8.3 EOS Contractor Interfaces and Data Flows

TBS

2.8.4 EOS Contractor Element Descriptions

The only current EOS contract is the EOS Spacecraft contract.

2.8.4.1 EOS Spacecraft Contractor Facilities

TBS

2.8.4.2 ECS Contractor Facilities

TBS

2.8.4.3 EOS IV&V Contractor Facilities

TBS

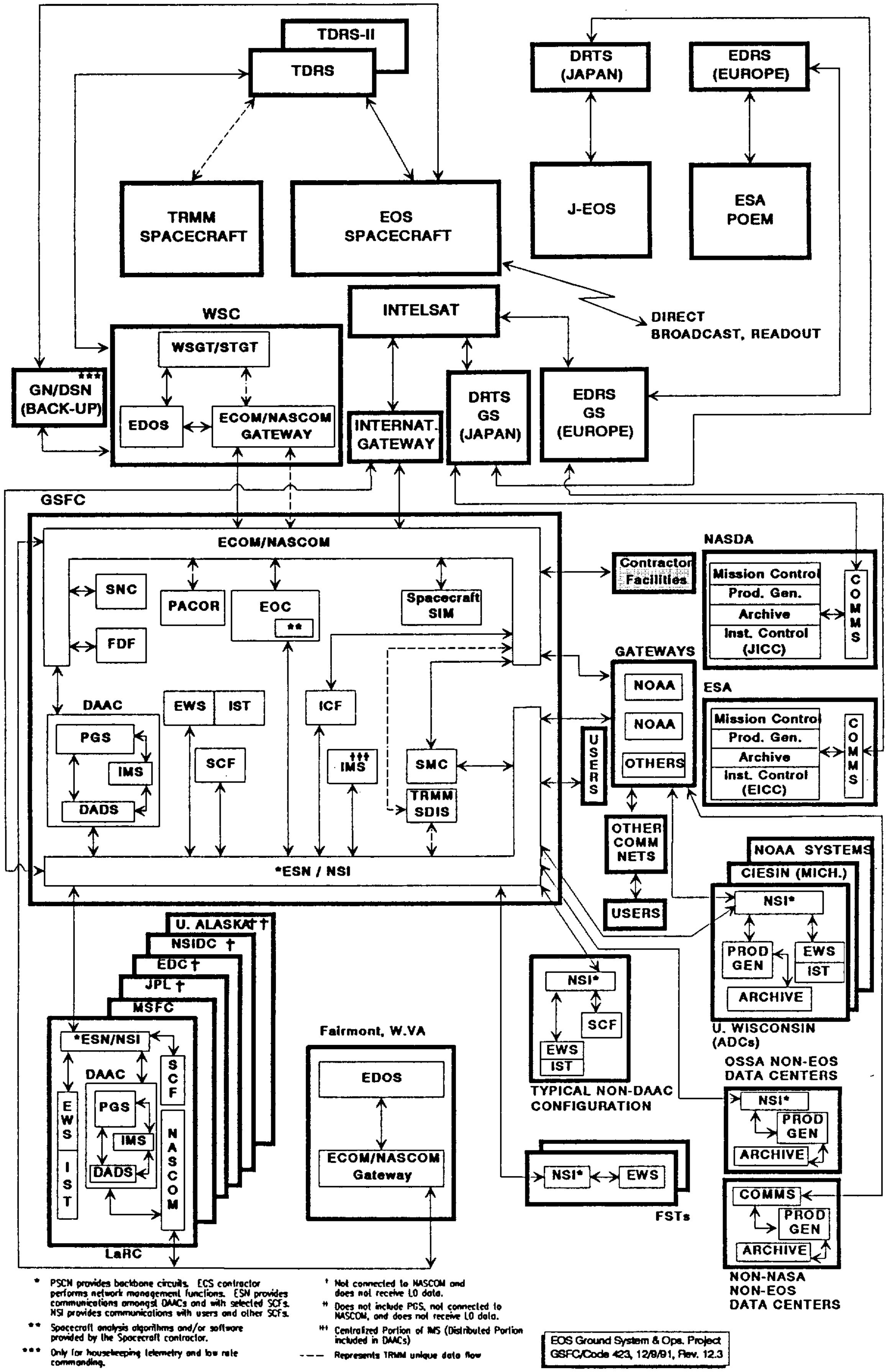

Figure 2.8.1-1: EOS Contractor Facilities Component in the Context of the EOS Ground System

2.9 CODE O INSTITUTIONAL SUPPORT SERVICES COMPONENT

2.9.1 Code O Institutional Support Services Component Relationship to Other Components

The relationship of Code O Institutional Support Services Component to the other ground system components is shown in Figure 2.9.1-1.

2.9.2 Code O Institutional Support Services

The Code O Institutional Support Services Component consists of several ground system elements which provide generic services to various projects, of which EOS is one, plus services unique to each project as required. These elements and a brief summary of the services they provide are listed in Table 2.9.2-1.

2.9.3 Code O Institutional Support Component Interfaces and Data Flows

The Code O Institutional Support Component interfaces and data exchanges are shown in Figure 2.9.3-1. The interfaces and data exchanges shown are external to the component. Interfaces between the elements internal to the component are shown in the element descriptions.

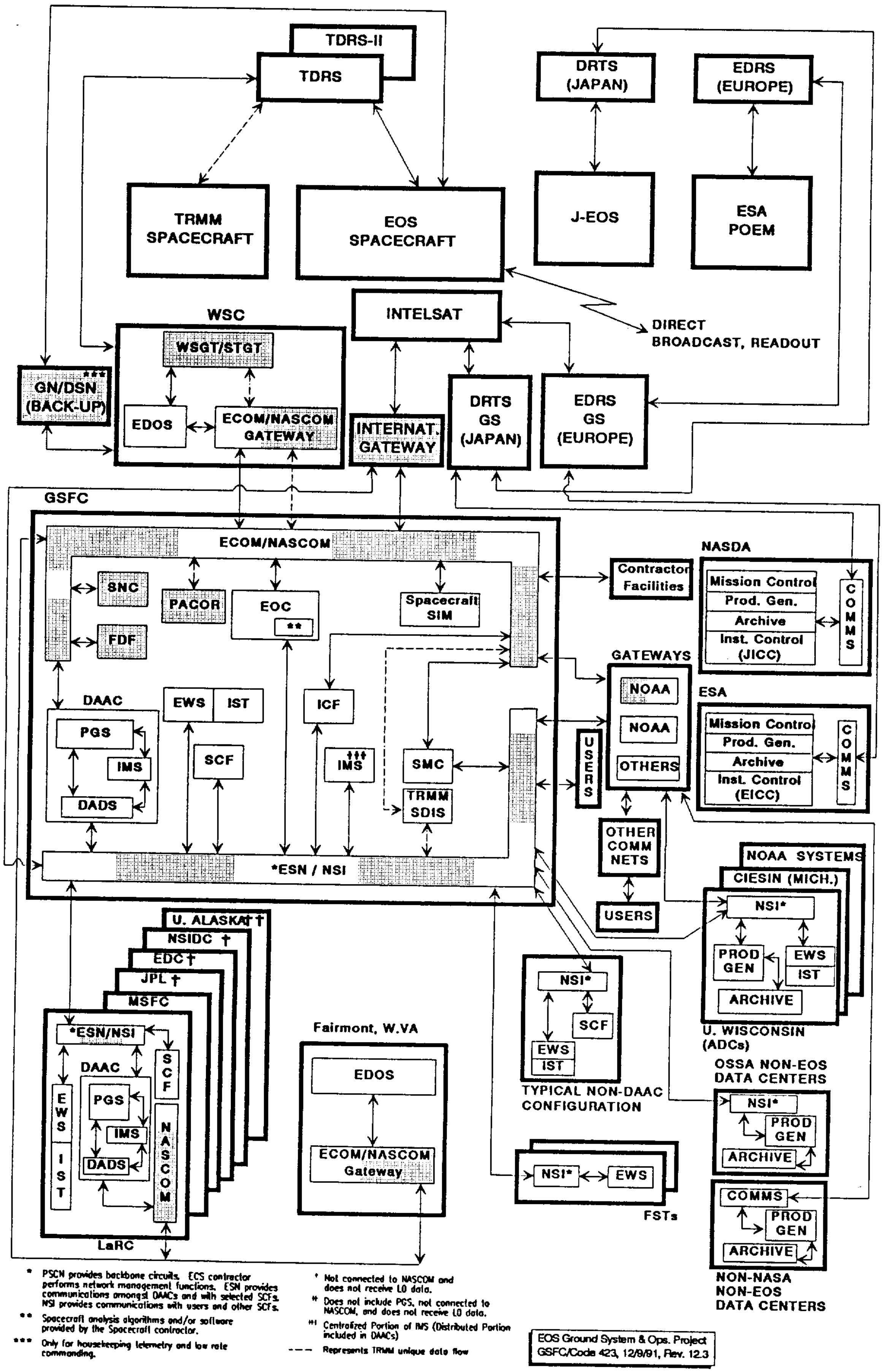

Figure 2.9.1-1: Code O Institutional Support Services in the Context of the EOS Ground System

Table 2.9.2-1. Services Provided by Code O Institution to EOS Program

Element	Service
White Sands Ground Terminal (WSGT)	Space Network/TDRSS space and ground communications and tracking services
Second TDRSS Ground Terminal (STGT)	Space Network/TDRSS space and ground communications and tracking services
ECOM/NASCOM Gateway	Protocol conversion and routing and switching functions
Deep Space Network (DSN) and Ground Network (GN)	Backup transmission services to/from the spacecrafts, in case of TDRSS/TDRS-II malfunction
Space Network Control (SNC)	Lead role in managing the applicable worldwide U. S. controlled Government communications networks, including the GN, DSN
Flight Dynamics Facility (FDF)	Predictive and definitive orbit, attitude and navigational computational support services to the Spacecrafts
NASCOM	Communication and data transport services between White Sands Complex (WSC) and ground located elements; and communication support for end-to-end spacecraft simulations and training

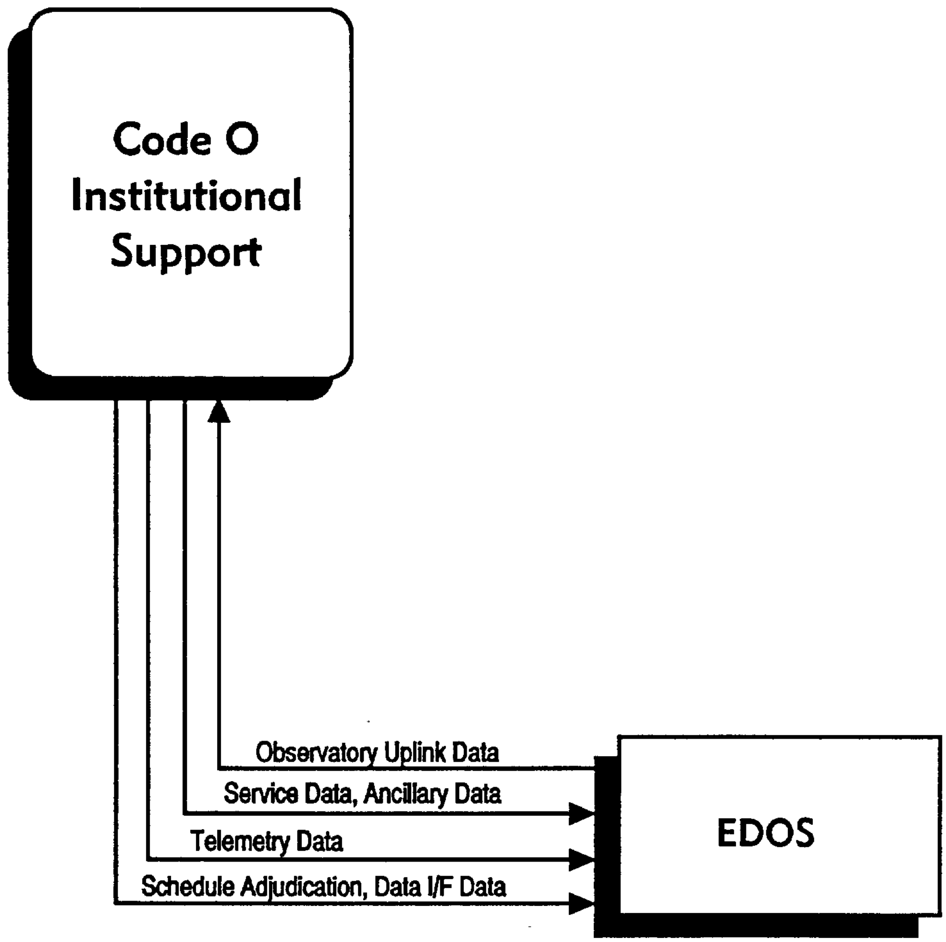

Figure 2.9.3-1: Code O Institutional Support Interfaces and Data Exchanges

2.9.4 Code O Institutional Support Element Descriptions

2.9.4.1 White Sands Ground Terminal (WSGT)

WSGT Location

Located near White Sands, New Mexico, the ground interfaces include a formerly leased, and now owned, Ground Terminal (WSGT) co-located with a NASA owned Ground Terminal (NGT).

WSGT Functions/Services

The White Sands Ground Terminal (WSGT) supports the SN/TDRSS space and ground communications and tracking services. Operational enhancements to the NASA owned WSGT/NGT are planned. When declared operational, the White Sands Complex (WSC) provides fully redundant and operational TDRSS Ground Terminals (TGT) in support of the EOS program, and other low orbiting missions.

WSGT Interfaces, Inputs, and Outputs

The interfaces to WSGT and the type of data transmitted between the interfacing elements is shown in Figure 2.9.4.1-1.

The types of data flowing into and out of WSGT are listed in Tables 2.9.4.1-1. and 2.9.4.1-2

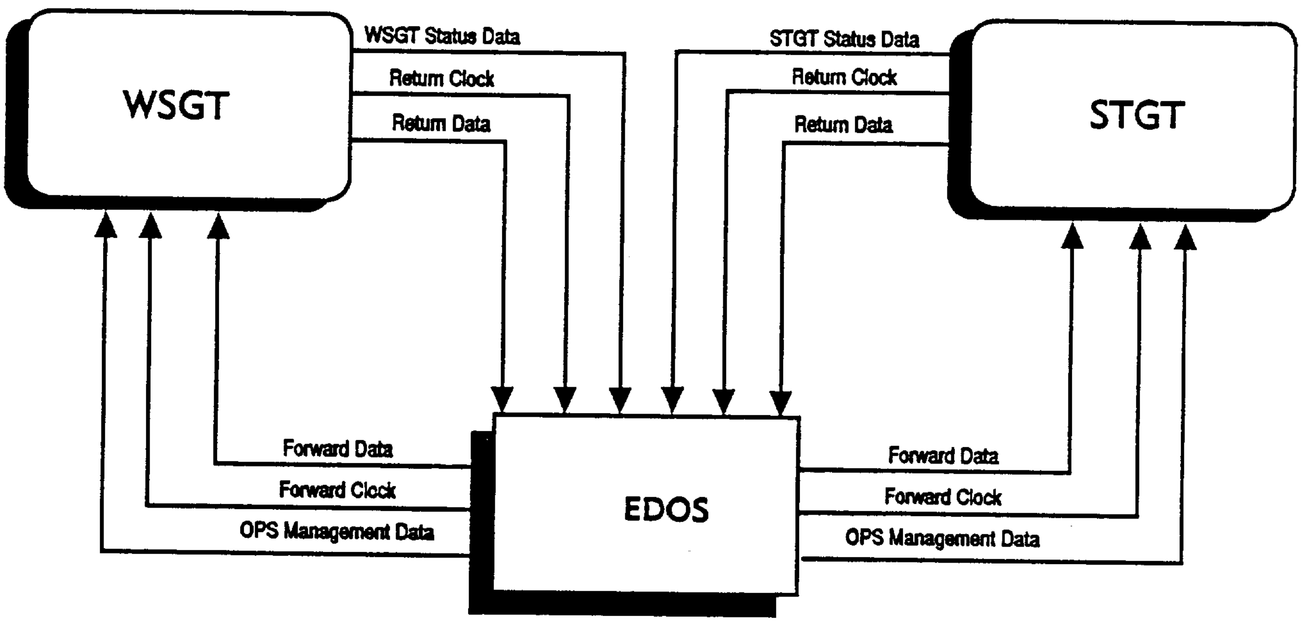

Figure 2.9.4.1-1: WSGT and STGT Interfaces and Data Exchanges

Table 2.9.4.1-1. Data Flow into WSGT/STGT

EDOS:	Forward data, forward clock; operations management data

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Table 2.9.4.1-2. Data Flow out of the WSGT/STGT

EDOS:	Return data, return data clock; WSGT/STGT status data

2.9.4.2 Second TDRSS Ground Terminal (STGT)

STGT Location

The STGT is located near White Sands, New Mexico.

STGT Functions/Services

The Second TDRSS Ground Terminal (STGT) initially provides backup support for TDRSS space and ground communications and tracking services. During enhancements to WSGT, the STGT will function as the primary ground terminal for the SN/TDRSS services supporting EOS. Following enhancement of the WSGT/NGT, the White Sands Complex will provide fully redundant and operational TDRSS Ground Terminals (TGTs).

STGT Interfaces, Inputs, and Outputs

The interfaces to the STGT and the types of data transmitted between the interfacing elements are shown in Figure 2.9.4.2-1. and Tables 2.9.4.1-1. and 2.9.4.1-2. under the discussion of the WSGT.

2.9.4.3 ECOM/NASCOM Gateway

The ECOM/NASCOM Gateway is discussed in Paragraph 2.2.4.2.

2.9.4.4 International Gateway

International Gateway Location

The International Gateway is located at TBD.

International Gateway Services/Functions

The International Gateway provides the communication interface between the EOS Ground System and its International Partners.

International Gateway Interfaces, Inputs, and Outputs

TBS

2.9.4.5 Ground Network (GN)/Deep Space Network (DSN)

GN/DSN Locations

The GN has tracking and data acquisition facilities at Bermuda and Merritt Island, Florida.

The DSN is managed by JPL, with facilities at Canberra, Goldstone, and Madrid.

GN/DSN Functions/Services

The GN provides launch and landing tracking and data acquisition (T&DA) support and backup (contingency T&DA) support to user spacecraft in primarily lower earth orbits. The EOS program will use GN services as a backup in case of loss of TDRS/TDRS-II connection. These services include backup RF communication services for relaying housekeeping telemetry and low bit rate commands between EDOS and the U.S. spacecrafts and earth probe free flyers.

The DSN provides tracking and data acquisition support to user spacecraft. EOS spacecraft will be supported with the 26 meter subnet. The EOS program will use DSN services as a backup in case of loss of TDRS/TRDS-II connection. These services include backup RF communication services for relaying housekeeping telemetry and low bit rate commands between EDOS and the U.S. spacecrafts.

GN/DSN Interfaces, Inputs, and Outputs

The interfaces to the GN and DSN and the type of data transmitted between the interfacing elements are shown in Figure 2.9.4.5-1.

The types of data flowing into and out of GN and DSN are listed in Tables 2.9.4.5-1. and 2.9.4.5-2.

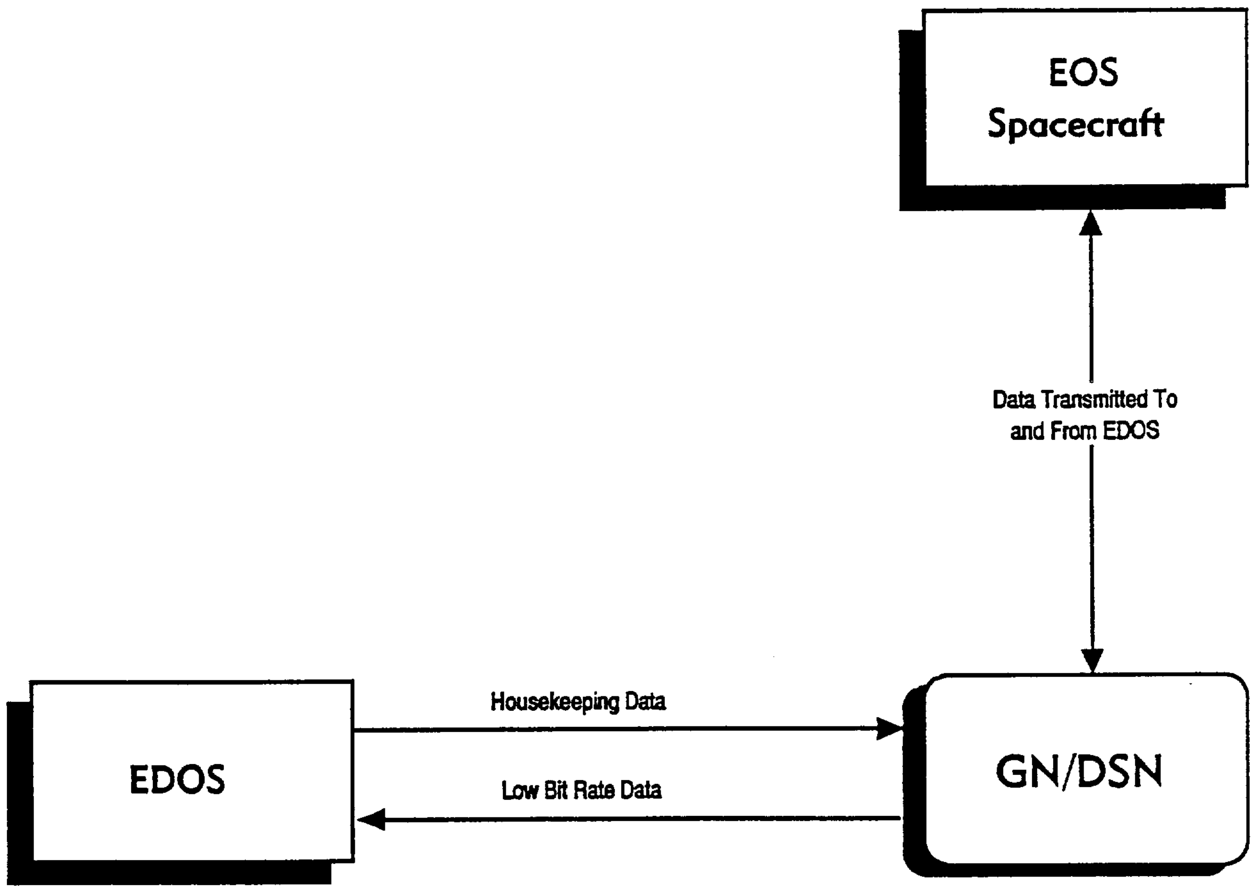

Figure 2.9.4.5-1: GN/DSN Interfaces and Data Exchanges

Table 2.9.4.5-1. Data Flow <u>into</u> the GN/DSN

EDOS:	Low bit rate commands

Table 2.9.4.5-2. Data Flow <u>out of</u> the GN/DSN

EDOS:	Housekeeping telemetry

2.9.4.6 Space Network Control (SNC)

SNC Location

The SNC will be located at GSFC.

SNC Functions/Services

The current Network Control Facility (NCC) will be replaced by the SNC at the end of 1997. The SNC functions will be augmented current NCC functions.

The major NCC functions are:

1) Scheduling of all network elements
2) Monitoring of the network's performance
3) Monitoring the status of network resources
4) Verification of network support configurations
5) Fault isolation coordination
6) Provision of user performance data
7) Management of ground configuration commands
8) Network support 24 hours per day, 7 days per week

The NCC provides operational management and control of the NASA Spaceflight Tracking and Data Network (STDN). Operationally, STDN includes the Space Network (SN) and the Ground Network (GN). Operationally, the NCC manages and schedules both the TDRSS and GN. The NCC is the point of contact for use of STDN including the TDRS, the WSC, interfaces to the NASCOM elements dedicated to the TDRSS, and the NASA GN. The SNC will interface to EDCOS elements. The SNC will be the primary support for EOS flight operations and interfaces with the EOC. EOS flight operations support includes allocation of SN resources and supporting EOS plans and schedules for use of the SN and GN. Additional SNC support to EOS includes TDRSS service control, performance monitoring, testing and integration of the EOS, EOSDIS and SN interfaces and conflict resolution. For example, the SNC processes an EOSDIS managed control center request for TDRSS schedules and contact times. The SNC resolves scheduling conflicts for SN resources between the EOC and other SN users (e.g. STS).

SNC Interfaces, Inputs, and Outputs

The interfaces to the SNC and the type of data transmitted between the interfacing elements are shown in Figure 2.9.4.6-1.

The types of data flowing into and out of the SNC are listed in Tables 2.9.4.6-1. and 2.9.4.6-2.

Table 2.9.4.6-1. Data Flow **into** the SNC

EOC:	Reconfiguration data; requests for TDRS contacts

Table 2.9.4.6-2. Data Flow **out of** the SNC

EOC:	Reconfiguration messages; TDRS schedules; status data

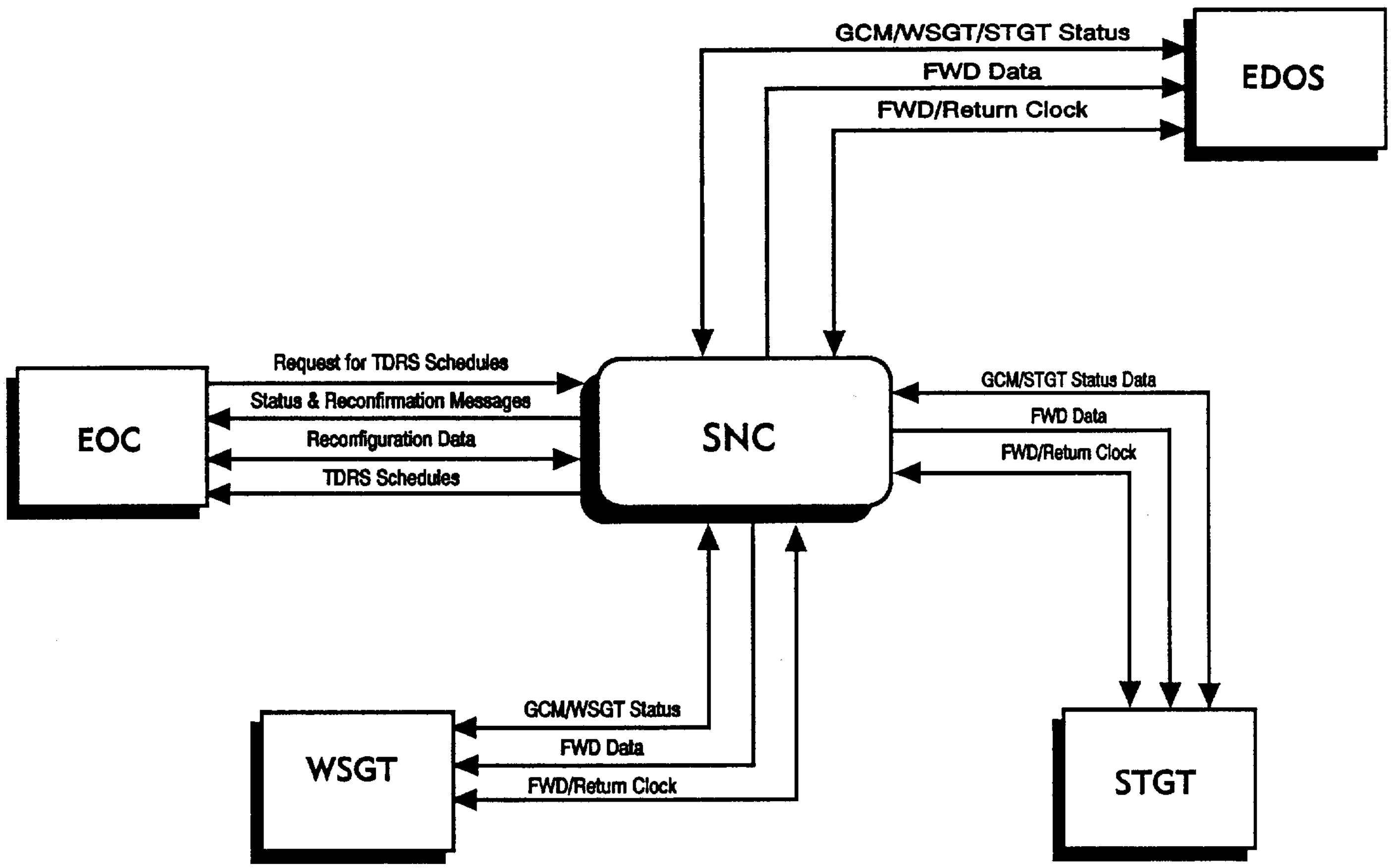

Figure 2.9.4.6-1: SNC Interfaces and Data Exchanges

2.9.4.7 Flight Dynamics Facility (FDF)

FDF Location

The FDF is located at GSFC.

FDF Functions/Services

The Flight Dynamics Facility (FDF) will provide orbital and computational facilities to support the EOS mission. The FDF provides predictive and definitive orbit, attitude and navigational computational support services to the EOS U.S. spacecrafts. Major functions of the FDF include:

1) Provide attitude determination support
2) Provide orbit maneuver and rendezvous support
3) Receive all tracking data transmitted to GSFC for real-time validation
4) Maintain a data base of tracking data to be used for orbit computations
5) Provide mission analysis support
6) Monitor and control the Bidirectional Ranging Transponder System (BRTS) network
7) Provide guidance, navigation, and control system verification
8) Perform prelaunch services (e.g. trajectory analysis, sensor analysis, and operations planning

Planned enhancements to the FDF architecture include:

1) Addition of a Sequential Orbit Determination System (SODS) in FY94 to fully achieve the accuracy which can be obtained with TDRSS and to make TDRSS tracking comparable to the Global Positioning System (GPS) for user orbit determination

2) Implementation of traditional services for EOS, including attitude determination, simulation and control, orbit determination and control, mission analysis, scheduling aid generation and Network support. Additionally, the downlinked attitude and orbit data will be spot checked throughout each day using EOC provided telemetry. Operationally, the FDF predicts, plans, and evaluates mission launch and orbital maneuvers, and provides and maintains a full sky star catalog for on-board and ground evaluation of spacecraft attitude. Mission launch and orbital maneuver support includes identifying the type of vehicle and burn rate, magnitude, attitude and duration.

FDF Interfaces, Inputs, and Outputs

The interfaces to the FDF and the types of data transmitted between the interfacing elements are shown in Figure 2.9.4.7-1.

The types of data flowing into and out of the FDF are listed in Tables 2.9.4.7-1. and 2.9.4.7-2.

Table 2.9.4.7-1.	Data Flow <u>into</u> the FDF
EOC:	Spacecraft sensor data for attitude determination and control; performance assessment or fault analysis results; fault isolation or performance assessment support requests; engineering and archive data
Network:	Metric tracking data

Table 2.9.4.7-2.	Data Flow <u>out of</u> the FDF
EOC:	Predicted Orbit data, precautioned orbit data, orbit adjust data, data used for scheduling contracts including User Antenna View and Predicted Site Acquisition Tables; corrective figure plans for orbit adjustments; orbit/attitude data; spacecraft orbit and attitude systems incipient or actual faults detected notice; orbit and attitude performance evaluation results; Guidance, Navigation and Control subsystem performance assessment request.
Network:	Acquisition data; scheduling data; tracking reports

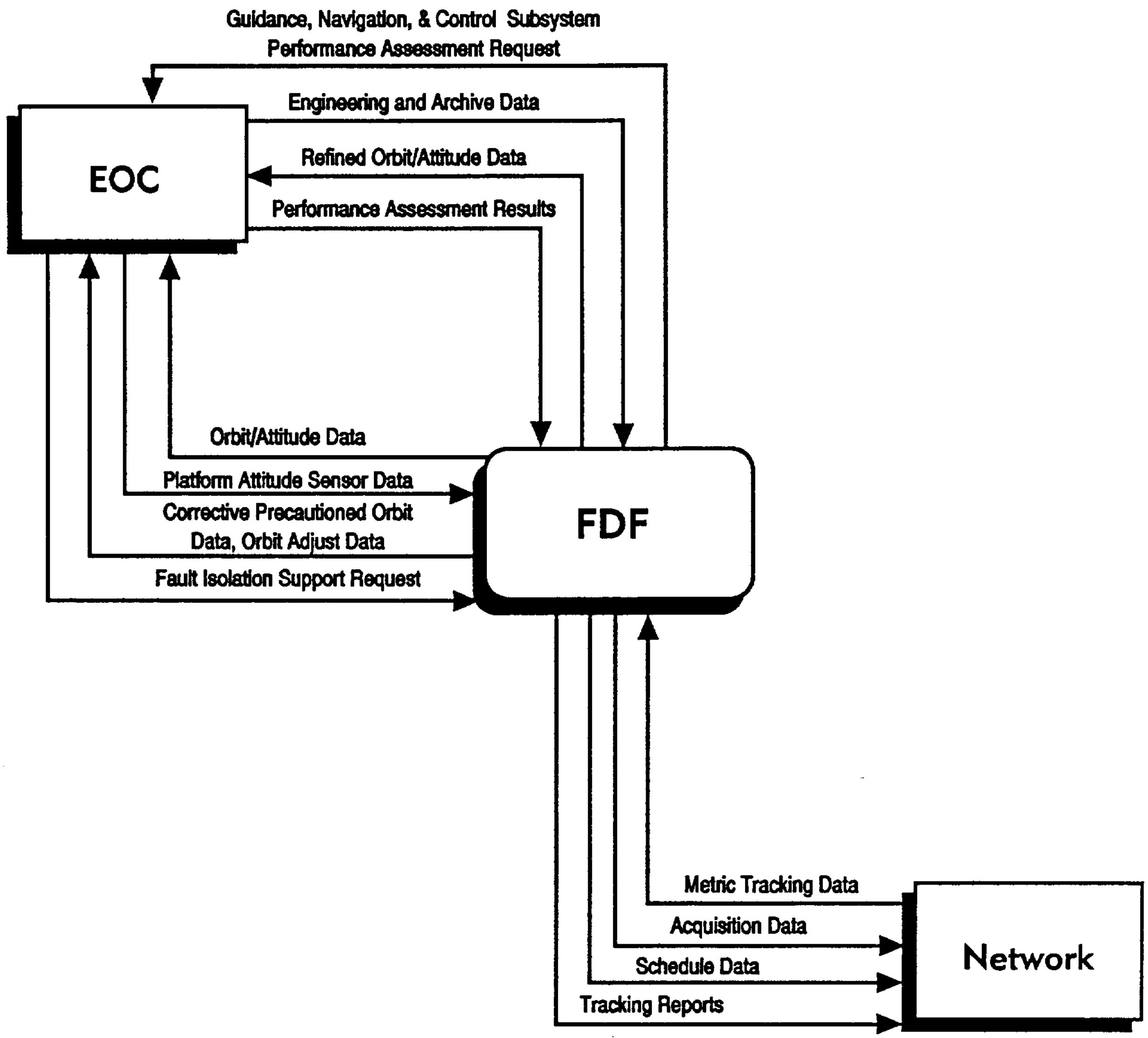

Figure 2.9.4.7-1: FDF Interfaces and Data Exchanges

2.9.4.8 NASCOM

NASCOM Location

NASCOM is the generic term referring to a worldwide complex of communication circuits, switching, and terminal services including voice, data teletype, and video systems that will serve NASA programs including EOS.

The current NASCOM Network contains a mixture of government owned and leased terminal equipment and communication services.

NASCOM Functions/Services

NASCOM will probide data communications services and operational networks for communications and data transport amoung various EOS Ground System elements (e.g., DAACs, EOC, ICF, etc.). The space systems supported by NASCOM will use a protocol specified by the Consultative Committee for Space Data Systems (CCSDS). The CCSDS packet created in space will be placed inside Virtual Channel Data Units (VCDUs). VCDUs are CCSDS Protocol Data Units (PDUs) used bidirectionally on the space-to-ground link. NASCOM will span the continental U. S. (CONUS), connecting major NASA sites. *[Note: Some parts of NASCOM are funded by OSSA and may be referred to as EOS Communications (ECOM).]*

The major functions of the NASCOM include providing:

1) Circuits for relay of real-time data for all network communications
2) Voice circuits for network coordination
3) Communications between all NASA facilities
4) Data circuits for test and prelaunch checkout
5) Communications between NASA facilities and external data processing
6) Bulk recordings and rate conversions of all high rate data where required
7) Video services

These functions will provide the required NASCOM support for the EOS ground system which include:

1) Accept and distribute science and operations data between EDOS and various other ground system elements
2) Provide bi-directional ground communications among ground elements
3) Provide communications support for end-to-end EOS spacecraft simulations and training

NASCOM Interfaces, Inputs, and Outputs

The interfaces to the NASCOM and the types of data transmitted between the interfacing elements is shown in Figure 2.9.4.8-1. The types of data flowing into and out of the NASCOM network to/from other elements using the network are listed in Tables 2.9.4.8-1. and 2.9.4.8-2. Types of data delivered between other elements via NASCOM are discussed in the element descriptions.

Table 2.9.4.8-1. Data Flow <u>into</u> the NASCOM

ESN:	Network operations related internetwork coordination messages exchanged between the ESN and NASCOM
IP, Non-EOS Networks:	Network operations related internetwork coordination messages exchanged with the IP networks and other non-EOS networks and NASCOM
All Elements:	Data to be delivered to other elements

Table 2.9.4.8-2. Data Flow <u>out of</u> the NASCOM

ESN:	Network operations related internetwork coordination messages exchanged between the ESN and NASCOM
IP, Non-EOS Networks:	Network operations related internetwork coordination messages exchanged with IP networks and other non-EOS networks and NASCOM
All Elements:	Data to be delivered to other elements

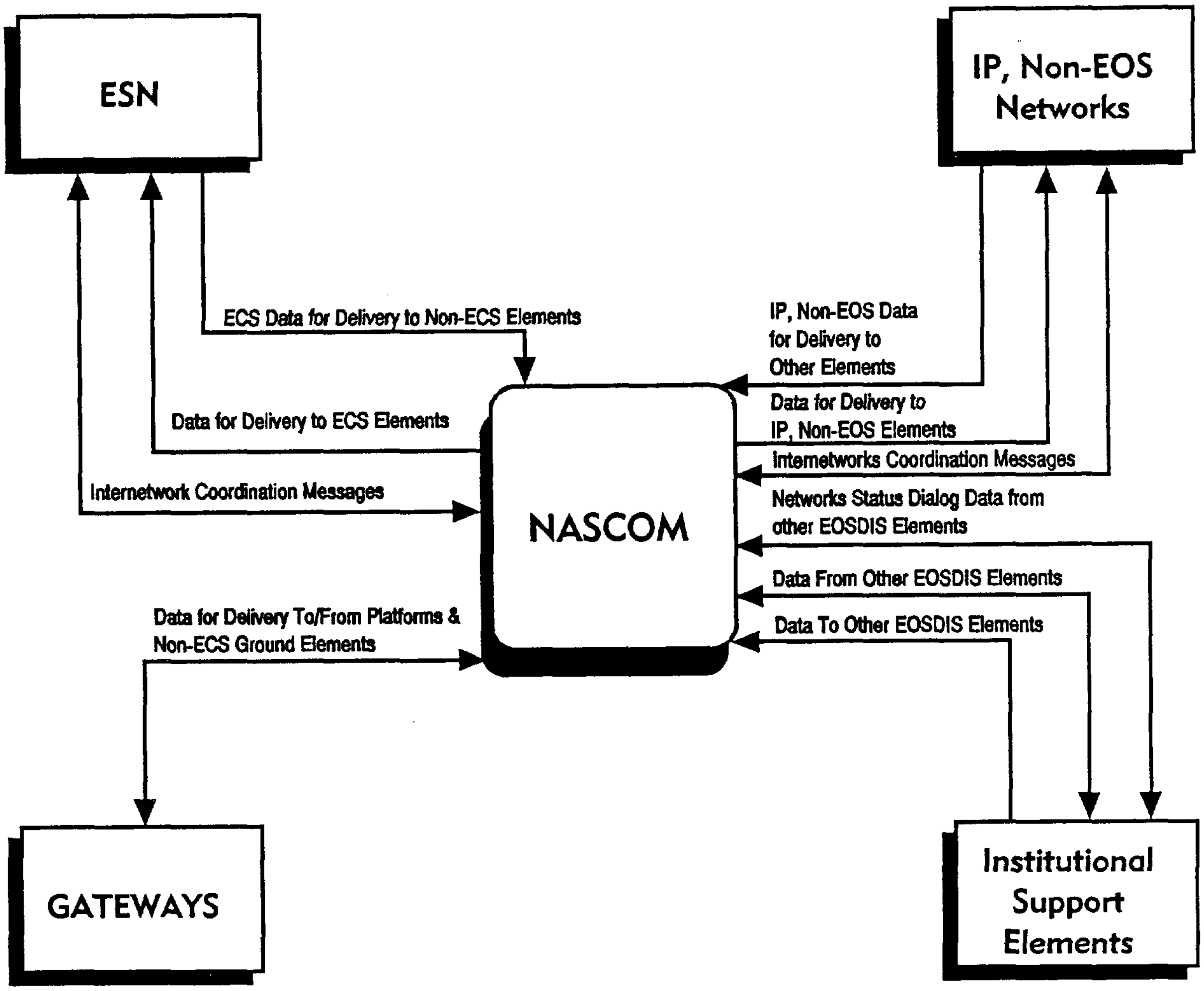

Figure 2.9.4.8-1: NASCOM Interfaces and Data Exchanges

ATTACHMENT A: EOS GROUND SYSTEM SCENARIOS

A.1.0 INTRODUCTION

This attachment contains a set of scenarios designed to provide an understanding of how the ground system architecture supports the EOS flight and ground operations.

The operational ground system can be divided into three major areas of functional responsibility - Mission operations, Instrument operations, and Data operations.

Mission operations encompass the coordination of EOS instrument operation on U.S. spacecrafts, the operation of the spacecraft and its support systems, and the scheduling and operational use of institutional services such as the Space Network, EDOS, the FDF, and the SNC. Mission operations activities are focused on normal data acquisition, but also include provision for determining the health and safety of the spacecraft and instruments, and for protecting the spacecraft and instruments from harm caused by the malfunction or misoperation of any instrument or system.

Instrument operations address the planning, scheduling, commanding and operation of the flight instruments. Each instrument's operations are constrained to work within the framework of overall spacecraft mission operations and each must schedule and/or share spacecraft services such as power and communications. Instrument operations are scheduled to meet the objectives of the EOS long term science plan.

Data operations include the receipt of instrument science data via the Space Network, and EDOS; the routine processing and reprocessing of the instrument data to standard data sets; cataloging and archiving of these data sets; the management of data, metadata and information; and the distribution of these data sets to the user community. Also included in data operations are access to instrument and spacecraft engineering data, and access to non-EOS data archives. Also, the receipt, archiving and distribution of non-standard EOS data products from the EOS investigators is a part of data operations.

Three high-level scenarios are provided here describing how the activities associated with the above three types of operations will be supported by the ground system architecture.

A.2.0 MISSION OPERATIONS SCENARIOS

The EOS Operations Center (EOC) is the focal point for mission operations. It serves as the control center for the U.S. spacecrafts and coordinates mission operations for U.S. and IP EOS instruments onboard U.S. spacecrafts. As the control center, the EOC provides a complete set of mission operations capabilities: planning and scheduling, command management, commanding, telemetry processing, offline analysis, and data management.

A.2.1 Planning and Scheduling Operations

The EOC Planning and Scheduling Service plans spacecraft operations and integrates spacecraft plans and schedules. The planning and scheduling process is one of refinement with addition of more detail to earlier versions of plans and schedules.

The mission operations planning process results in a Short Term Operations Plan (STOP) generated weekly covering the next 28 days. The Flight Operations Team generates and transmits TDRSS schedule requests, based on the requirements identified in the STOP, to the SNC which provides TDRSS active schedule forecasts to be used in implementing the STOP.

They also generate or update a Core Activity Specification (CAS) which defines the activities to be performed on the spacecraft. The CAS is used to generate or update a Conflict Free Schedule at least once a day covering the next seven days.

The EOC provides the FDF with a telemetry stream subset containing attitude and orbit sensor data. The FDF provides predicted orbit data, including predicted ground track information for scheduling, and contact scheduling data, including User Antenna View data and Predicted Site Acquisition Tables. The EOC, in cooperation with the Spacecraft Analysis Software assists the FDF in developing plans for corrective firings for orbit adjusts which is then scheduled and implemented by the EOC.

Planning and scheduling information is exchanged with the Spacecraft Analysis Software; the Spacecraft Analysis Software provides the EOC with information and recommended procedures for core system activities and predicted core resource availability (used in the CAS), and the EOC provides the Spacecraft Analysis Software with PCAR information, operation schedules, and accept/reject status.

A.2.2 Command Management Operation

The EOC provides management of preplanned uplink data for the EOS spacecrafts and instruments based primarily on the Conflict Free Schedule developed by the EOC Planning and Scheduling Service. The Mission Operations preplanned uplink data consists of core-stored spacecraft data and commands and spacecraft software memory loads.

The PTTS provides the spacecraft software memory loads to the EOC. The EOC Command Management Service generates and validates core-stored spacecraft tables based on the schedule. It integrates the core-stored spacecraft commands in preparation for uplink, manages spacecraft computer stored command memory, packages commands for on-board storage, and produces a memory map for the spacecraft stored command processor. It packages the core-stored command loads, spacecraft software memory loads, core-stored spacecraft table loads, and instrument microprocessor memory loads into spacecraft memory loads in a form ready to be received onboard. It ensures that the uplinks are planned so the onboard system can fulfill the activities specified in the Conflict Free Schedule. It generates command load reports for use by the EOC Commanding Service.

A.2.3 Commanding Operations

The EOC provides the capability to transmit real-time commands and spacecraft memory loads to the EOS spacecraft via EDOS.

The real-time commands are generated by the EOC operators and are validated by the EOC Commanding Service. They are incorporated into an spacecraft memory load in one uplink stream.

The EOC provides the spacecraft memory load in CCSDS format to EDOS for uplink to the spacecraft. It verifies via telemetry the successful receipt of the commands by the spacecraft, receives and evaluates spacecraft command transmission status information from EDOS. It generates appropriate command-related event messages for display to the operators and for history logging, and maintains a record of the uplink status of spacecraft memory loads and real-time commands.

A.2.4 Telemetry Processing Operations

The EOC provides the capability to receive and process both real-time and playback telemetry engineering data from the spacecrafts. These data are downlinked from the spacecraft in CCSDS packets to EDOS which transfers the packets to the EOC after performing data reversal for any packets downlinked in reverse chronological order. The packets directed to the EOC contain real-time spacecraft housekeeping data, playback spacecraft housekeeping data, and spacecraft processor memory dump data.

The EOC's Telemetry Processing Service decommutates the contents of the packets, performing the necessary conversions and calibrations and determining values for other derived parameters. Various forms of limit checking is performed on the telemetry parameters, and made available to the operator through the EOC User Interface Service.

The playback data are initially recorded as they are received. After it is captured, the data are processed at an operator-selected reduced rate. The operator examines the data defining spacecraft behavior and perform more in-depth analysis of the data when he is ready.

This service will extract the subset of the telemetry stream containing attitude & orbit sensor data for transfer to the FDF.

The EOC Telemetry Processing Service also processes non-telemetry data related to the telemetry data. This includes messages from the SNC, monitor blocks from the DSN, GN, and Wallops ground station received via EDOS, and status messages from EDOS.

A.2.5 Spacecraft Analysis Operations

The EOC's Spacecraft Analysis Service provides the EOC operators with information needed to perform spacecraft systems management, performance analysis, trend analysis, configuration management, and resource management. These functions are performed off-line, but a subset will be used to process in real-time.

This service provides the capability to perform analyses on real-time data, playback data, and EOC history logs. It reports on the quality of the data used for analysis, failures detected, and identify marginal system operation. The EOC operators can evaluate performance for a specified time interval or for individual spacecraft core systems. The operators analyze the performance of command and data handling, the power, thermal, communications, and guidance, navigation and control subsystems.

The operators perform short term trend analysis to determine degradation of services; configuration management to determine and control the state of the spacecraft core systems; make spacecraft configuration changes to correct for component failures, anomalies, or to satisfy operational requirements. They monitor spacecraft resources, propellant, energy balance, power levels, battery temperature, state of battery charge, and thermal load balance.

The EOC resolves spacecraft failures and anomalies, and coordinates their resolution with other elements. It recommends courses of actions for selected contingency situations.

A.2.6 Data Management Operations

The EOC Data Management Service maintains an EOS project database and a history log. The database contains descriptions of the spacecraft housekeeping data formats, housekeeping parameter descriptions, command and display formats, and operator directives needed to evaluate the health and safety of the spacecraft. The history log is used for maintaining the records of the spacecraft operations activities.

The Spacecraft Analysis Software provides some of the initial content and updates to the database.

The history log or a subset with associated metadata is sent to a designated DADS or the Spacecraft Analysis Software. The DADS returns storage status. The EOC exchanges mission status data with the IP MOCs. It provides spacecraft status data to the ICCs.

It stores operator guides and operational procedures online for operator support.

A.3.0 INSTRUMENT OPERATIONS SCENARIO

The ICCs are the focal point for instrument operations. There is functionally one ICC for each U.S.instrument. The international partners are expected to have functionally equivalent ICCs for their instruments onboard the U.S. spacecrafts. The ICCs are responsible for planning, scheduling, commanding, and monitoring of their instruments, DAR processing, telemetry processing, instrument analysis, and instrument data management. They provide the instrument control commands and parameters to the EOC, and the EOC performs the actual transmission of commands and parameters to the instruments in accordance with the Short Term Operations Plan (STOP) and the Conflict Free Schedule, which use the Short Term Instrument Plans (STIPs) from the ICCs as input.

Instrument Support Terminals (ISTs) provide instrument PIs/TLs capabilities at their home facilities for viewing and interacting with their ICCs for the respective instrument operations.

The EOC provides many of the same types of services in accomplishing instrument operations as it does for mission operations. The difference is that the inputs to and the outputs from the instrument operations process are instrument oriented with different sources and destinations from the mission operations process. EOC resolves any conflicts in DAR and prepares a conflict free schedule.

A.3.1 DAR Processing Operation

Authorized users may generate a Data Acquisition Request by completing a DAR submittal form with the help of an IMS toolkit resident at an ICC, then sending it to the IMS. The IMS performs a high level reasonability check on the DAR and forwards it to the EOC for further evaluation and scheduling. The EOC sends the DAR to the ICC for analysis. The ICC can communicate with the DAR originator for modification or clarification, and will then provide analysis results to the EOC which will incorporate the DAR requirements into the overall scheduling of the instruments and spacecrafts.

A.3.2 Planning and Scheduling Operations

The planning and scheduling operation for instruments begins with the Instrument Working Group (IWG) which send the Long Term Instrument Plan (LTIP) and the Long Term Science Plan (LTSP) to the ICC via the SMC. The ICC iterates on the plan with the EOC until the EOC can incorporate it into its overall schedule for transmission to the instruments. The ICC provides interactive scheduling capabilities to the PI/TL at the IST to aid in the schedule decision making process.

A.3.3 Command Management Operations

Instrument command management is a function of the ICC. It provides the non-realtime generation of instrument commands and loads required for operation of the instrument. It generates and assembles the commands, tables and instrument microprocessor memory loads, all of which are managed by the ICC. It also prepares core-stored instrument commands, core-stored instrument tables, instrument preplanned command groups using command information it gets from the ICC instrument data base. These must be managed by the EOC and the spacecraft after generation by the ICC. Instrument command groups are not stored on board for delayed execution but, when issued from the ground, are executed immediately on board. Command groups are transmitted by the ICC to the EOC for storage and later uplink or for immediate uplink. The ICC also accepts IST instrument microprocessor loads from a PI/TL.

A.3.4 Commanding Operation

Instrument commands generated in the instrument command management operations are transferred to the EOC or IPMOC, as appropriate. Emergency/contingency commands are generated and validated by the ICC, and provided to the EOC or IP MOC for immediate uplink.

A.3.5 Telemetry Processing Operations

Instrument health and safety data and spacecraft housekeeping data are transmitted by EDOS in real-time or playback mode directly to the ICC. The ICC extracts relevant spacecraft parameters and instrument housekeeping data from the spacecraft housekeeping data stream. It uses the data for both short term instrument health, safety, and performance monitoring activities and for instrument trend monitoring, which is provided to the ISTs when needed for analysis. The ICCs periodically and in response to anomalous conditions provide instrument status reports to the EOC.

A.3.6 Instrument Analysis Operations

The EOC sends DARs to the ICC for initial instrument analysis. The ICC returns the result of the analysis, which may include a further refinement of the DAR and an assessment of its technical feasibility and its consistency with the long term instrument and science plans. These analyses include trend analysis, performance analysis, and instrument configuration monitoring, and may be performed on real-time, playback, or history log data. The ICC may receive quick-look science data directly from EDOS, or quick-look science data products from a DAAC to be used in its analyses. The ground image of the instrument microprocessor memory is maintained by the ICC which compares it to memory dumps. The ICC provides fault management for the instrument and participates in fault resolution of instrument and ICC interface faults. The ICC coordinates the analysis with the IST.

A.4.0 DATA OPERATIONS SCENARIO

The focal point of data operations is the DAACs, but the related activities span the entire ground system. Raw data is acquired by the instruments and telemetered to the ground via the Space Network to EDOS, which performs initial processing and directs the data to their final destination, which is either the appropriate DAAC or, in the case of IP instruments, the IP equivalent of a DAAC.

Level 1 through 4 processing of the data is performed by the DAAC's Product Generation System (PGS), and the products are archived in the DAAC's DADS. Authorized users can access the archived data via the IMS, and can return results of their investigation to the archive.

Data operations involve five distinct data handling activities: data acquisition, data processing, data archive, data distribution, and data management.

A.4.1 Data Acquisition Operations

The data acquisition process begins with instrument sensor measurements and ends with delivery of the measurements to the appropriate destinations. The measurements are taken in response to DAR commands generated by the ICCs and uplinked by the EOC. They are transmitted by telemetry via STGT to EDOS, which extracts raw data from the stream and either forwards it to a specified destination or performs Level 0 processing and then forwards it to its destination. In case of TDRS/ATDRS failure, the data is telemetered to EDOS via either the Ground Network or the Deep Space Network as backup.

A.4.2 Data Processing Operations

There are five levels of processing defined for the data, called Level 0 through Level 4. Level 0 is the first processing level, taking the raw data (telemetry stream) and reconstructing the unprocessed instrument data at full space-time resolution, appending all available information (e.g. ephemeris, health, safety) to be used in subsequent processing. It is generally performed by EDOS, the exceptions being direct delivery of telemetry data by broadcast downlink, such as to the IPs.

Level 1 through 4 processing is performed by the DAACs' PGS, supported by the co-located DADS, except that Level 1 processing for the ASTER instrument is performed by the Japanese ground system before transmission to the DAAC.

Level 1 processing unpacks and reformats Level 0 data, and radiometrically corrects and calibrates data in physical units at full instrument resolution as acquired.

Level 2 processing derives environmental variables (e.g. ocean wave height, soil moisture, ice concentration) at the same resolution and location as the Level 1 source data.

Level 3 processing spatially and/or temporally resamples data or derives environmental variables derived from Levels 1 or 2 which may include averaging and compositing.

Level 4 processing analyzes the lower level derived data and produces model output or other results.

PGS Level 1 through Level 4 processing produces standard products that are generated on a regularly scheduled basis or upon specific requests from the science community.

A.4.3 Data Archive Operations

EDOS provides initial archive capabilities for Level 0 data, as required. Permanent archival is provided by the DAACs' DADS.

EDOS provides short-term (24 hour) data storage for all EOS spacecraft and instrument data, and provides storage for engineering and operations data in support of EOSDIS priority playback operations.

EDOS and the International Partners send their Level 0 and quick-look data to the appropriate DADS for archiving. The DADS stores data products from its collocated PGS, special data products and other information from the SCFs, and ancillary and other data from other archives and institutions.

All DADS archived data are available to authorized users.

A.4.4 Data Distribution Operations

Initial distribution of data is done by EDOS. It extracts housekeeping data for transmission to the EOC for analysis by the EOC and by Spacecraft Analysis Software. Instrument housekeeping data is sent by the EOC to the appropriate ICC for analysis by the PI/TL. Science data is sent by EDOS to the DAACs responsible for the data from each instrument.

The DADS at each DAAC site provides the data to its collocated PGS which after generating specified products, returns the products to the DADS for further distribution to the users, as requested.

There is a front-end process at each DADS to ingest incoming data from networks. Data to be sent to or received from the PGS is stored in a staging area.

Data distribution, both via networks and on physical media, is the function of a distribution control process, which ingests data coming in via media, and is alerted if a product received from the PGS is on a list of standing orders. If so, the DADS distributes the product to the requestor.

A.4.5 Data Management Operations

The focal point for data and information management operations is the IMS.

The SMC sends directives and user registration information to the IMS, and in return the IMS provides status information and requests for user registration information to the SMC.

The IMS sends product orders for archival data products, algorithms, EOC historical data, spacecraft housekeeping and ancillary data, and documentation to the DADS and receives product and documentation metadata, and product order status from the DADS. As data products are archived and metadata updates are inserted at the various DADS, each DADS sends metadata updates for inclusion in the IMS directory and inventory of data sets.

The IMS access the PGS product processing schedules for display to users, sends requests for processing to the PGS, and receives product status from the PGS. Once the processing thread for the products has been installed at the PGS, the IMS sends one initial processing order to the PGS, which thereafter routinely schedules the production of the products.

The ICC sends instrument information and the EOC sends spacecraft information and data acquisition schedules and plans to the IMS which will provide it to users to assist in completing a DAR. Once completed, the IMS performs a high level reasonability check on the DAR and forwards it to the EOC for further evaluation and scheduling. As the DAR moves through the EOC scheduling process, the EOC provides DAR status to the IMS.

ATTACHMENT B: EOS GROUND SYSTEM EXTERNAL INTERFACES

This attachment documents the identified EOS Ground System External Interfaces, the lead organization responsible for specifying the requirements for the interface, and the support organization responsible for responding to those requirements. The documentation consists of a set of charts that have been refined, updated, and presented at the periodic meetings of the Ground System Integration Working Group (GSIWG).

GSFC EOS GROUND SYSTEM

EXTERNAL INTERFACES

EXTERNAL INTERFACE PROCESSES

EXTERNAL INTERFACES IDENTIFIED BY ANALYSIS OF REQUIREMENT - RESPONSE PROCESS

- FIVE (5) MAJOR PROCESSES IDENTIFIED

  I. CODE S (ECS) ↔ CODE S (NON-ECS PART OF CODE S)

  II. CODE S (EDOS) ↔ CODE S (NON-ECS PART OF CODE S)

  III. CODE S ↔ INTERNATIONAL PARTNERS (IP)

  IV. CODE S ↔ OTHER US GOVT. AGENCIES (NOAA, USGS, etc.) and to UNIVERSITIES, etc.

  V. CODE S ↔ CODE O

- 24 MAJOR CLASSES OF INTERFACES IDENTIFIED

CODE S: Office of Space Science and Applications (OSSA)

CODE O: Office of Space Operations (OSO)

MAJOR GROUND SYSTEM EXTERNAL INTERFACES RESPONSIBILITIES

SUPPORT / LEAD	DAACs	ADCs	EDOS	CODE 500 INST.	JPL DSN	CODE 421 (GROUND)	CODE 422 PIs, TLs, TMs	NOAA	ESA*	NASDA/ MITI*	NON-EOS CENTERS	EXT. NETS.	EOSDIS [V0, SCFs]	CODE 423 ECS **
CODE 423 ECS **	X† 2	X† 3				X 5	X 6	X 7	X 8	X 9	X† 10	X 40	X 41	
EDOS								X 13	X 14	X 15				X 42
CODE 500 INST.			X 44			X 48		X 21	X 22	X 23				X 46
CODE 421 (FLIGHT)			X 25	X 26	X 27									
JPL DSN			X 36											

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* REPRESENTS JOINT INTERFACE/AGREEMENT <u>WITHOUT</u> LEAD/SUPPORT ROLES

** REPRESENTS NOAA IN ESA, NASDA/MITI AGREEMENTS

† UNIQUE INTERFACE MAY BE NEEDED FOR EACH DAAC, ADC, AND NON-EOS DATA CENTER

NOTES

- Numbers in each cell are used as pointers to refer to specific interfaces throughout the rest of this attachment. The numbers are not always consecutive because some interfaces have been deleted and their assigned number has been retired. As new interfaces are identified, they are assigned the next consecutive number.

- There are 24 interface classes. Each interface class is represented by an "X" on the table.

- "*LEAD ROLE*" refers to the organization(s) (e.g., Project, Contractor, etc.) that has primary responsibility to implement the respective interface(s).

NOTES (continued)

- "*SUPPORT ROLE*" refers to the organization(s) (e.g., Project, Contractor, etc.) that has primary responsibility to support the lead organization in implementing respective interfaces.

- Code O Institutional Elements include:

  - Space Network
    (TDRSS/TDRSS-II, WSC, SNC)

  - NASCOM@@

  - Flight Dynamics Facility (FDF)

  - Ground Network (GN)

  - Deep Space Network (DSN)

@@ Parly funded by OSSA. The OSSA-funded parts may also be referred to as EOS Communications (ECOM).

EXTERNAL INTERFACES/RESPONSIBILITIES

CODE S (ECS) ↔ CODE S (NON-ECS)

SUPPORT / LEAD	DAACs	ADCs	EDOS	CODE 500 INST.	JPL DSN	CODE 421 (GROUND)	CODE 422 PIs, TLs, TMs	NOAA	ESA*	NASDA/ MITI*	NON-EOS CENTERS	EXT. NETS.	EOSDIS [V0, SCFs]	CODE 423 ECS **
CODE 423 ECS **	X† 2					X 5	X 6				X† 10	X 40	X 41	
EDOS														X 42
CODE 500 INST.														
CODE 421 (FLIGHT)														
JPL DSN														

MGSB1291.DRW2

* REPRESENTS JOINT INTERFACE/AGREEMENT WITHOUT LEAD/SUPPORT ROLES

** REPRESENTS NOAA IN ESA, NASDA/MITI AGREEMENTS

† UNIQUE INTERFACE MAY BE NEEDED FOR EACH DAAC, ADC, AND NON-EOS DATA CENTER

7 CLASSES OF INTERFACES

EXTERNAL INTERFACES

	LEAD	PRIMARY SUPPORT
2. **ECS ↔ DAACs:**		
ECS ↔ DAACs (DAAC-UNIQUE)	ECS	RESPECTIVE DAAC INSTITUTIONS
5. **ECS ↔ CODE 421 GROUND:**		
EOC ↔ SPACECRAFT SIM	ECS	SPACECRAFT CONTRACT
6. **ECS ↔ CODE 422:**		
ECS ↔ PIs	ECS	CODE 422 SCIENCE OFFICE
ECS ↔ [TLs, TMs]	ECS	CODE 422 SCIENCE OFFICE
10. **ECS ↔ Non-EOS DATA CENTERS:**		
ECS ↔ TRMM SDIS	ECS	TRMM SDIS
DAACs (MSFC, LaRC) ↔ TRMM SDIS	ECS	TRMM SDIS

EXTERNAL INTERFACES

	LEAD	**PRIMARY SUPPORT**
40. **ECS ⟷ EXT. NETWORKS:**		
ESN ⟷ NSI	ECS	NSI
41. **ECS ⟷ V0, SCFs:**		
ECS ⟷ V0		
ECS ⟷ V0 DAACs	ECS	Respective V0 DAAC Institution
ECS ⟷ V0 IMS	ECS	Respective V0 IMS Institution
ECS ⟷ SCFs:		
DAAC ⟷ SCFs	ECS	Respective SCFs
ESN ⟷ SCFs	ECS	Respective SCFs
42. **ECS ⟷ EDOS:**		
GSFC ECS ⟷ EDOS:		
EOC ⟷ EDOS	EDOS	ECS
DAACs ⟷ EDOS	EDOS	ECS
ICF ⟷ EDOS (GSFC)	EDOS	ECS
IMS ⟷ EDOS	EDOS	ECS

EXTERNAL INTERFACES/RESPONSIBILITIES

CODE S (EDOS) ↔ CODE S (NON-ECS)

SUPPORT / LEAD	DAACs	ADCs	EDOS	CODE 500 INST.	JPL DSN	CODE 421 (GROUND)	CODE 422 PIs, TLs, TMs	NOAA	ESA*	NASDA/ MITI*	NON-EOS CENTERS	EXT. NETS.	EOSDIS [V0, SCFs]	CODE 423 ECS **
CODE 423 ECS **														
EDOS														
CODE 500 INST.														
CODE 421 (FLIGHT)			X 25											
JPL DSN														

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* REPRESENTS JOINT INTERFACE/AGREEMENT <u>WITHOUT</u> LEAD/SUPPORT ROLES

** REPRESENTS NOAA IN ESA, NASDA/MITI AGREEMENTS

1 CLASS OF INTERFACES

EXTERNAL INTERFACES

	LEAD	PRIMARY SUPPORT
25. **CODE 421 FLIGHT ⟷ EDOS:**		
EOS SPACECRAFT ⟷ EDOS	SPACECRAFT CONTRACT	EDOS CODE 500

EXTERNAL INTERFACES/RESPONSIBILITIES

CODE S ↔ U.S. GOV'T AGENCIES, UNIVERSITIES, ETC.

SUPPORT / LEAD	DAACs	ADCs	EDOS	CODE 500 INST.	JPL DSN	CODE 421 (GROUND)	CODE 422 PIs, TLs, TMs	NOAA	ESA*	NASDA/ MITI*	NON-EOS CENTERS	EXT. NETS.	EOSDIS [V0, SCFs]	CODE 423 ECS **
CODE 423 ECS **		X † 3						X 7			X † 10	X 40		
EDOS								X 13						
CODE 500 INST.														
CODE 421 (FLIGHT)														
JPL DSN														

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* REPRESENTS JOINT INTERFACE/AGREEMENT <u>WITHOUT</u> LEAD/SUPPORT ROLES

** REPRESENTS NOAA IN ESA, NASDA/MITI AGREEMENTS

† UNIQUE INTERFACE MAY BE NEEDED FOR EACH DAAC, ADC, AND NON-EOS DATA CENTER

5 CLASSES OF INTERFACES

EXTERNAL INTERFACES

CODE S ↔ U.S. GOV'T AGENCIES, UNIVERSITIES, ETC.

	LEAD	PRIMARY SUPPORT
3. **ECS ↔ ADCs:**		
DAACs ↔ ADCs	ECS	U. WISC CIESIN NOAA
IMS ↔ ADCs	ECS	U. WISC. CIESIN NOAA
ESN ↔ ADCs	ECS	U. WISC. CIESIN NOAA
7. **ECS ↔ NOAA:**		
IMS ↔ NOAA	ECS	NOAA
DAACs ↔ NOAA	ECS	NOAA

EXTERNAL INTERFACES

CODE S ↔ U.S. GOV'T AGENCIES, UNIVERSITIES, ETC.

	LEAD	PRIMARY SUPPORT
10. ECS ⟷ NON-NASA, NON-EOS DATA CENTERS:		
DAACs ⟷ NON-NASA NON-EOS DATA CENTERS	ECS	RESPECTIVE INSTITUTIONS
IMS ⟷ NON-NASA NON-EOS DATA CENTERS	ECS	RESPECTIVE INSTITUTIONS
13. EDOS ⟷ NOAA:		
EDOS ⟷ NOAA	EDOS	NOAA
40. ECS ⟷ EXT. NETWORKS:		
ESN ⟷ NOAA NETWORKS	ECS	NOAA

EXTERNAL INTERFACES/RESPONSIBILITIES

CODE S ↔ IPs

SUPPORT / LEAD	DAACs	ADCs	EDOS	CODE 500 INST.	JPL DSN	CODE 421 (GROUND)	CODE 422 PIs, TLs, TMs	NOAA	ESA*	NASDA/MITI*	NON-EOS CENTERS	EXT. NETS.	EOSDIS [V0, SCFs]	CODE 423 ECS **
CODE 423 ECS **									X 8	X 9		X 40		
EDOS									X 14	X 15				
CODE 500 INST.														
CODE 421 (FLIGHT)														
JPL DSN														

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* REPRESENTS JOINT INTERFACE/AGREEMENT <u>WITHOUT</u> LEAD/SUPPORT ROLES

** REPRESENTS NOAA IN ESA, NASDA/MITI AGREEMENTS

5 CLASSES OF INTERFACES

EXTERNAL INTERFACES

	LEAD	PRIMARY SUPPORT	COMMENTS
8. **ECS ↔ ESA:**			
EOC ↔ IPOC			JOINT RESPONSIBILITY BETWEEN ECS & ESA
IMS ↔ ESA			JOINT RESPONSIBILITY BETWEEN ECS & ESA
DAACs ↔ ESA DAACs			JOINT RESPONSIBILITY BETWEEN ECS & ESA
NOAA EICC ↔ IPOC			JOINT RESPONSIBILITY BETWEEN ECS & ESA WITH SUPPORT FROM NOAA
9. **ECS ↔ NASDA:**			
EOC ↔ IPOC			JOINT RESPONSIBILITY BETWEEN ECS & NASDA/MITI
IMS ↔ NASDA/MITI			JOINT RESPONSIBILITY BETWEEN ECS & NASDA/MITI
DAACs ↔ NASDA/MITI DAACs			JOINT RESPONSIBILITY BETWEEN ECS & NASDA/MITI

EXTERNAL INTERFACES

	LEAD	PRIMARY SUPPORT	COMMENTS
14. **EDOS ↔ ESA:**			
EDOS ↔ ESA			JOINT RESPONSIBILITY BETWEEN ECS AND ESA WITH SUPPORT FROM EDOS
15. **EDOS ↔ NASDA/MITI:**			
EDOS ↔ NASDA/MITI			JOINT RESPONSIBILITY BETWEEN ECS AND NASDA/MITI WITH SUPPORT FROM EDOS
40. **ECS ↔ EXT. NETWORKS:**			
ESN ↔ NASDA/MITI NETWORKS			JOINT RESPONSIBILITY BETWEEN ECS AND NASDA/MITI
ESN ↔ ESA NETWORKS			JOINT RESPONSIBILITY BETWEEN ECS AND ESA

EXTERNAL INTERFACES/RESPONSIBILITIES

CODE S ↔ CODE O

SUPPORT / LEAD	DAACs	ADCs	EDOS	CODE 500 INST.	JPL DSN	CODE 421 (GROUND)	CODE 422 PIs, TLs, TMs	NOAA	ESA*	NASDA/ MITI*	NON-EOS CENTERS	EXT. NETS.	EOSDIS [V0, SCFs]	CODE 423 ECS **
CODE 423 ECS **														
EDOS														
CODE 500 INST.			X 44			X 48		X 21	X 22	X 23				X 46
CODE 421 (FLIGHT)				X 26	X 27									
JPL DSN			X 36											

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* REPRESENTS JOINT INTERFACE/AGREEMENT <u>WITHOUT</u> LEAD/SUPPORT ROLES

** REPRESENTS NOAA IN ESA, NASDA/MITI AGREEMENTS

9 CLASSES OF INTERFACES

EXTERNAL INTERFACES

	LEAD	PRIMARY SUPPORT	COMMENTS
21. **CODE 500 INSTITUTIONAL ⟷ NOAA:**			
NASCOM ⟷ NOAA	CODE 500	ECS NOAA	
22. **ESA <—> CODE 500 INSTITUTIONAL :**			
ESA <—> CODE 500			JOINT RESPONSIBILITY BETWEEN ECS AND ESA WITH SUPPORT FROM CODE 500 AND APPROPRIATE AGREEMENTS WITH INTELSAT
23. **NASDA <—> CODE 500 INSTITUTIONAL:**			
NASDA <—> CODE 500			JOINT RESPONSIBILITY BETWEEN ECS AND NASDA/MITI WITH SUPPORT FROM CODE 500 AND APPROPRIATE AGREEMENTS WITH INTELSAT

EXTERNAL INTERFACES

	LEAD	PRIMARY SUPPORT
26. **CODE 421 FLIGHT ↔ CODE 500 INSTITUTIONAL:**		
EOS SPACECRAFT ↔ CODE 500 INST.	SPACECRAFT CONTRACT	CODE 500
EOS SPACECRAFT ↔ GN	SPACECRAFT CONTRACT	CODE 500
27. **CODE 421 FLIGHT ↔ JPL DSN:**		
EOS SPACECRAFT ↔ DSN	SPACECRAFT CONTRACT	JPL DSN
36. **JPL DSN ↔ EDOS:**		
JPL DSN ↔ EDOS	JPL DSN	EDOS
44. **EDOS ↔ CODE 500 INSTITUTIONAL:**		
EDOS ↔ CODE 500 INST.	CODE 500	EDOS
EDOS ↔ GN	CODE 500	EDOS

EXTERNAL INTERFACES

	LEAD	PRIMARY SUPPORT
46. **ECS ↔ CODE 500 INSTITUTIONAL:**		
ECS ↔ FDF	CODE 500	ECS
ECS ↔ SNC	CODE 500	ECS
ECS ↔ NASCOM@@	CODE 500	ECS
ECS ↔ PSCN	CODE 500 MSFC	ECS
* DAACs (MSFC, LaRC) ↔ PACOR	CODE 500	ECS
48. **CODE 500 INSTITUTIONAL ↔ CODE 421 GS:**		
NASCOM ↔ SPACECRAFT SIM	CODE 500	ECS SPACECRAFT CONTRACT

@@ Parly funded by OSSA. The OSSA-funded parts may also be referred to as EOS Communications (ECOM).

* For TRMM LIS and CERES data.

ATTACHMENT C: ACRONYMS

This attachment contains a list of the acronyms used in this document and their definitions.

A

ADC	Affiliated Data Center
ACRIM	Active Cavity Radiometer Irradiance Monitor
AIRS	Atmospheric Infra-Red Sounder
ALT	Altimeter Instrument
AMSR	Advanced Microwave Scanning Radiometer
AMSU	Advanced Microwave Sounding Unit
APID	Application Packet Identifier
ASF	Alaska SAR Facility
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer

B

BRTS	Bilateration Ranging Transponder System

C

C&DH	Command and Data Handling
CIESIN	Consortium for International Earth Science Information Network
CERES	Clouds and Earth's Radiant Energy
CAC	Climate Analysis Center
CCSDS	Consultative Committee For Space Data Systems
CFS	Conflict Free Schedule
CO-I	Co-Investigator
CONUS	Continental U.S.

D

DAAC	Distributed Active Archive Center
DADS	Data Archive and Distribution System
DAR	Data Acquisition Request
DDS	Data Delivery Services
DLS	Dynamic Limb Sounder
DRTS	Data Relay and Tracking Satellite (Japan)
DSN	Deep Space Network

E

ECOM	EOS Communications
ECS	EOSDIS Core System
EDC	EROS Data Center
EDOS	EOS Data and Operations System
EDRS	European Data Relay Satellite
EEMOC	European EOS Mission Operations Center
EICC	ESA Instrument Control Center
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EOSP	Earth Observing Scanning Polarimeter
EPOP	European Polar Orbiting Platform
ERBE	Earth Radiation Budget Experiment
ERIM	Environmental Research Institute of Michigan
ESA	European Space Agency
ESN	EOS Science Network
EWS	EOS Work Station

F

FDF	Flight Dynamics Facility
FOT	Flight Operations Team
FST	Field Support Terminal

G

GGI	GPS Geoscience Instrument
GCRP	Global Change Research Program
GN	Ground Network
GOES	Geostationary Operational Environmental Satellite
GOSIP	Government Open Systems Interconnection Profile
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
GSIWG	Ground System Integration Working Group

H

HIMSS	High-Resolution Microwave Spectrometer Sounder
HIRDLS	High-Resolution Dynamic Limb Sounder
HIRIS	High-Resolution Sounding Unit
HQ	Head Quarters
HRTR	High Rate Tape Recorder

I

IAS	Instrument Activity Specification
ICC	Instrument Control Center
ICF	Instrument Control Facility
IMS	Information Management System
IP	International Participant/Partner
IPD	Information Processing Division
IPEI	Ionospheric Plasma and Electrodynamic Instrument
IPOC	International Partner Operations Center(s)
ISAR	Instrument Science Acquisition Request
ISO/OSI	International Standards Organization/Open Systems Interconnection
IST	Instrument Support Terminal
ITIR	Japanese Intermediate Thermal Infrared Radiometer
IWG	Investigator Working Group

J

JEMOC	Japanese EOS Mission Operations Center
JICC	Japanese Instrument Control Center
JPL	Jet Propulsion Laboratory
J-EOS	Japanese Polar Orbiting Platform
JSC	Johnson Space Center

L

L0-L4	Level 0 through Level 4 (processing)
LAN	Local Area Network
LaRC	Langley Research Center
LAWS	Laser Atmospheric Wind Sounder
LIS	Lightning Imaging Sensor
LOC	Launch Operations Center
LSM	Local System Management
LTIP	Long Term Instrument Plan

LTOP	Long Term Operation Plan
LTSP	Long Term Science Plan
LZP	Level 0 Processing

M

Mbps	Megabits per second
MIMR	Multifrequency Imaging Microwave Radiometer
MISR	Multi-angle Imaging Spectro-Radiometer
MITI	Ministry of International Trade and Industry (Japan)
MLS	Microwave Limb Sounder
MO&DSD	Mission Operations and Data Systems Directorate
MOC	Mission Operations Center
MODIS-N	Moderate-Resolution Imaging Spectrometer (nadir viewing)
MODIS-T	Moderate-Resolution Imaging Spectrometer (tilt viewing)
MOPITT	Measurements of Pollution in the Troposphere
MOM	Mission Operations Manager
MSFC	Marshall Space Flight Center

N

NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NASDA	National Space Development Agency - Japan
NCC	Network Control Center
NESDIS	National Environmental Satellite Data and Information Service (NOAA)
NGT	NASA Ground Terminal
NMC	National Meteorological Center
NOAA	National Oceanographic and Atmospheric Administration
NODS	NASA Ocean Data System
NSCAT	NASA Scatterometer
NSI	National Science Internet
NSSDC	National Space Science Data Center
NWS	National Weather Service

O

ODC	Other Data Centers
OSDPD	Office of Space Data Processing and Distribution
OSO	Office of Space Operations (Code O)
OSSA	Office of Space Science and Applications (Code S)

P

PACOR DCF	Packet Processor Data Capture Facility
PCAR	Platform Core Activity Request
PDP	Production Data Processor
PDU	Protocol Data Unit
PGS	Product Generation System
PI	Principal Investigator
PLDS	Pilot Land Data System
Platform SIM	Platform Simulation
POCC	Payload Operations and Control Center
POEM	Polar Orbit Earth Observation Mission
PSAT	Predicted Site Acquisition Tables
PSCN	Program Support Control Network
PTTS	Platform Test and Training System

Q

QA	Quality Assurance
QL	Quick Look

R

RF	Radio Frequency

S

SAGE	Stratospheric Aerosol and Gas Experiment
SAM	Stratosphere Aerosol Measurement
SAS	Spacecraft Analysis Software
SAR	Synthetic Aperature Radar
SCAT	Scatterometer
SCF	Science Computing Facility
SDAC	Science Data Analysis Center
SDSD	Satellite Data Services Division
SeaWiFS	Sea-Viewing Wide Field Sensor
SIRD	Support Instrumentation Requirements Document
SMC	System Management Center
SN	Space Network
SNC	Space Network Control
SOCC	Science Operations and Control Centers
SODS	Sequential Orbit Determination System
SSEC	Space Science and Engineering Center

SSI	Science Support Interface
STDN	Spaceflight Tracking and Data Network
STGT	Second TDRS Ground Terminal
STIKSCAT	Six Stick Scatterometer
STIP	Short Term Instrument Plan
STOP	Short Term Operation Plan
STS	Space Transportation System (Space Shuttle)
SVSC	Saginaw Valley State College
SWIRLS	Stratospheric Wind Infrared Limb Sounder

T

T&DA	Tracking and Data Acquisition
TDRS	Tracking and Data Relay Satellites
TDRSS	Tracking and Data Relay Satellite System
TDRS-II	Advanced TDRS
TGT	TDRSS Ground Terminals
TES	Tropospheric Emission Spectrometer
TL	Team Leader
TM	Team Member
TOO	Target(s) Of Opportunity
TRMM	Tropical Rain Measuring Mission
TSDIS	TRMM Science Data and Information System

U

UAV	User Antenna View
UARS	Upper Atmosphere Research Satellite
USGS	United States Geological Survey
U. Alaska	University of Alaska
U. WISC	University of Wisconsin

V

VC	Virtual Channel
VCDU	Virtual Channel Data Unit

W

WSC	White Sands Complex
WSGT	White Sands Ground Terminal